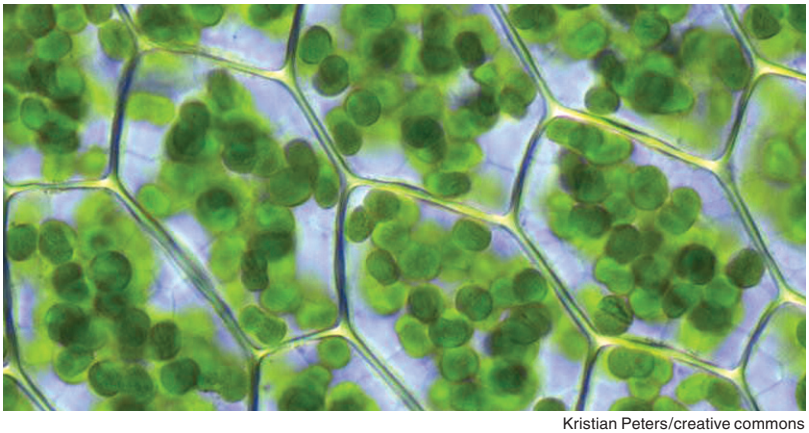
21st CENTURY SCIENCE & TECHNOLOGY

Vol. 23, No. 2 Summer 2010

Features



Kristian Peters/creative commons

Plant cells of the moss Plagiomnium affine*, showing visible chloroplasts. Why do some plants take up heavier or lighter isotopes?*

On the Cover: Artist's concept of NASA's Phoenix Mars Lander, just before its 2008 touch-down on the arctic plains of Mars. Illustration courtesy of NASA/JPL-Caltech/University of Arizona; cover design by Alan Yue.

News

Departments

21st Century Science & Technology (ISSN 0895-6820) is published 4 times a year by 21st Century Science Associates, 60 Sycolin Road, Suite 203, Leesburg, Va. 20175. Tel. (703) 777-6943.

Address all correspondence to **21st Century**, P.O. Box 16285, Washington, D.C. 20041.

21st Century is dedicated to the promotion of unending scientific progress, all directed to serve the proper common aims of mankind.

Opinions expressed in articles are not necessarily those of 21st Century Science Associates or the scientific advisory board.

We are not responsible for unsolicited manuscripts.

Electronic subscriptions are $25 for 6 issues or $48 for 12 issues. Back issues (1988-2005) are $5 each ($8 foreign). Electronic issues from 2006 on are $5 each. Payments must be in U.S. currency.

ISSN 0895-682

www.21stcenturysciencetech.com

NAWAPA: An Anti-Entropic Upshift In Global Economy

The theories of Adam Smith and Karl Marx converge upon the erroneous belief that physical economic value is created by the labor of the individual operative at the point of production in factory, farm, or mine. The history of human creative mastery over nature, that is, physical economy, proves otherwise. It is not the individual hours of labor embodied in a commodity, but the total development of the physical and conceptual infrastructure of economic organization, which determines the productivity of the individual and the society as a whole, and therefore defines economic value.

NAWAPA, the North American Water and Power Alliance, will be the next dramatic proof of this basic truth. NAWAPA is the program, first projected in 1964 by the Parsons Engineering Company, to bring fresh water, now lost as runoff to the Pacific and Arctic Oceans, southward to the dry regions of the Canadian and American West, Southwest, and plains states, and to northern Mexico.

By diverting approximately 117 million acre feet per year (about 17 percent) of the unused runoff from the mountains of Alaska and the Yukon Territory, NAWAPA will provide enough fresh water to assure adequate water supplies for the next century or more. An additional flow, up to 48 million acre-feet per year as required, from the unused runoff of the eastern slopes of the Rocky Mountains and Arctic Basin will be diverted into the Great Lakes to alleviate falling water levels and pollution, and increase power production. An included result will be the creation of a navigable waterway from Vancouver on the Pacific to Lake Superior, and another to the Arctic Ocean.

In the process of solving the desperate need for water in the western regions, this massive engineering project will transform the economic geography of the North American continent by creating a sea link between the Atlantic and the Pacific and Arctic Oceans. The value of goods produced in the interior of the continent thus increases, and the vast untapped mineral potential of the Far North is opened up. New towns and cities will arise in interior regions, bringing with them the opportunity for cultural development.

In addition, NAWAPA will generate a surplus of hydroelectric power. When that is combined with a renaissance in nuclear power production, including the urgent production of at least 6,000 new 1-gigawatt nuclear plants by the year 2050, a truly human living standard for all the world's people can be achieved.

The greatest power requirement for NAWAPA, comes at the Sawtooth Lift on the Idaho-Montana border, where the entire mass of water accumulated in the Rocky Mountain Trench, must be lifted about half a mile up. While originally designed to be powered by diversion of water into falls that would eventually reach the Columbia River, the use of nuclear power to drive the massive pumps would avoid the waste of a great volume of water. It is an ideal location for a cutting-edge nuclear facility, employing advanced reactor designs, and perhaps incorporating prototype hydrogen fuel production capabilities.

The proximity of the Idaho National Laboratory, where the Department of Energy's research on advanced reactor design is conducted, and of the Hanford complex in Washington state is fortuitous.

Man-Made Climate Change

NAWAPA is also a program for climate change. NAWAPA will bring an amount of water sufficient to irrigate 86,300 square miles of newly productive agricultural land. This is the equivalent of a 35 mile-wide strip of farmland stretching for 2,500 miles, from 500 miles north into the Canadian agricultur-

LPAC-TV

The North American Water and Power Alliance, proposed in the 1960s, is a program to truly green the United States, and uplift the nation and world in the process. For a brief video overview of the project, see http://www.larouchepac.com/node/15570. Other NAWAPA videos are available at www.larouchepac.com.

al belt, to 200 miles south of the border into Mexico. Increased photosynthesis—the proper use for solar energy!—will mean an increase in rates of evapotranspiration, water vapor content of the air, and cloud cover.

The vast irrigated areas will create local microclimates, bringing an estimated 2.7 inches of rainfall for every inch of water supplied. Further, the increase in groundwater flow over broad areas will mean a conversion of marginally arid scrubland to prairie.

Along with NAWAPA will come the next phase of development of the railway grid, an intercontinental link across the Bering Strait and a railway link through the Darién Gap from North to South America. A Bering Strait tunnel will connect North America by land to the markets of Eurasia, forever changing the Atlantic orientation of trade. A rail passage through the Darién Gap, the still-unfinished section of the Pan American highway, combined with the long-delayed development of a South American railway system, means the final end to poverty and underdevelopment for the Hemisphere.

Human Economy Is Anti-Entropic

From the time of the earliest recorded transformations in man's relationship to nature, characterized by scientific advances in astronomically guided transoceanic navigation, the source of economic value has always resided, not at the point of production of commodities for exchange or use, but rather in ideas. The uniquely human capability for discovery and transmission of new universal principles, and the incorporation of such principles into means for transforming nature to the benefit of present and future generations, is the true and only location of value.

As the successive exponential improvements in human relative population density potential over history demonstrate, that process of human creative intervention into nature, puts to rest all silly ideas of a universal principle of entropy. Human economy is anti-entropic, and willfully so. Thus, any physical theory which seems to prove the universal existence of a law of entropy is, by definition, false. Entropy is not a universal law but a restricted one. The theorizer has left out of his theory the possibility of his own existence.

The urgent question for today is: How best to foster the global expansion of human creative potential to achieve that urgently needed anti-entropic upshift in human physical economy which can carry us into the future? A mobilization of national economic resources for NAWAPA provides the answer to that urgent question. With NAWAPA and the related development projects worldwide, we can achieve that necessary turnaround in global economy which will make the future of the human race secure for the coming century. The end to global hunger and poverty, the tragically overdue development of the underdeveloped nations of the world, and the preparation of mankind for the journey into the Solar System and beyond, all await us.

There is no other viable proposal in sight. Solar panels and windmills will not cut the cake. A failure to act now for the urgent implementation of the NAWAPA program means a descent into hell, its adoption a renaissance for humanity.

—Laurence Hecht

South Africa's Folly

The South African Cabinet's recent decision to stop funding the Pebble Bed Modular Reactor project is a self-defeating folly that dooms the majority of that nation's people to a hopeless future. In effect, the Cabinet has closed down a main avenue to future financial prosperity in the name of current cost-cutting.

No nation can prosper without a science driver, a challenging long-term mission, like President Kennedy's 1960s Apollo Program in the United States. Such a project multiplies the initial investment many-fold: Every dollar spent on the Apollo Project returned 10 dollars or more to the economy, by conservative estimates. And it educated and inspired millions of people around the world.

For South Africa, the PBMR is such a science driver, creating a mission for the South African nation at the frontiers of nuclear science and engineering. It put South Africa on the map as a leader of the coming revolution in power production: building a fourth-generation reactor that is meltdown-proof, affordable, mass-producible, quick to construct, and very suitable for use in industrializing the developing sector.

The governmental cost involved—a few tens of millions of dollars over the past 11 years—is not much, by big project standards, even for a developing economy. First-of-a-kind reactors necessarily cost more than later models will cost, coming off an assembly line. And by definition, such projects come up against unexpected and often costly problems. Whatever was spent, however, pales in comparison to the incalculably high loss to the future of the nation, by shutting down the PBMR.

The South Korean Model

South Africa could learn from studying South Korea's nuclear program. In 1958, after years of war, when the nation was in shambles and its population near starvation, the decision was made to put precious funds into developing from scratch a nuclear program, which would not begin to bear fruit for at least 20 years. The mission succeeded, as can be seen in South Korea's position today as an exporter of nuclear plants, and a nation with a high per capita income. Had the South Korean government not taken that risk, of investing in the development of a then-new technology, it would not have rocketed from least-developed country status to a world industrial leader.

Nuclear vs. Malthus

There is no way to power a modern industrial economy without nuclear (and in the future, fusion energy). No other sources come near the energy flux density of these advanced power sources. Those who argue for windmills and solar will keep South Africa in poverty. It is no accident that the environmentalist movement worldwide was launched by the Malthusian oligarchs Prince Philip and the late Prince Bernhard of the Netherlands, who want to reduce world population down to 2 billion. South Africa and other developing nations are slated to contribute the lion's share of those 4 billion or so deaths required to satisfy Prince Philip and the renewables he advocates.

The de-funding of the PBMR (like the proposed de-funding of a Moon-Mars program and lack of nuclear investment in the United States), is a sure way to a new dark age. Likewise, throwing millions into useless so-called "green" technologies will only serve to keep the African continent in the dark.

The scientific way to compare power production sources is to look at comparative energy flux densities, in which nuclear power is many millions of times ahead of the alternatives, including gas and coal. Because of its energy flux density, nuclear power has a transformative capability for the physical economy, which renewables are totally lacking.

Think about it: Could you provide the high temperatures and cheap source of heat to liquefy coal with renewables? Could you feed all your people, and supply them with the 3 to 5 kilowatts of power per capita, necessary in a modern economy? Could you get to the Moon or Mars in a wind-powered rocket?

—Marjorie Mazel Hecht

Wind and Wickedness

To the Editor:

As a physicist (energy expert) and long-time environmental advocate, I applaud your efforts to educate the public about energy issues (e.g. Laurence Hecht, "The Astounding High Cost of 'Free' Energy," www.21stcenturysciencetech. com/Articles%202008/Energy_cost.pdf).

After talking to a *lot* of people about renewables (like wind power), my conclusion is that almost everyone has only a superficial understanding of this very technical matter. Additionally, the public and political perception of wind energy is being driven by special interest lobbyists, and by environmentalists who are well-intentioned but misguided.

My belief is that such complex technical matters should be based on science, rather than on inputs from those who stand to economically or politically profit.

The simple webpage where I have collected some pertinent documents is at http://windpowerfacts.info.

John Droz, Jr.
Crystal Coast, N.C.

The Editor Replies

We would add one crucial point of clarification: While some environmentalists could fairly be characterized as well-intentioned dupes, the character of the movement itself is fascist. The program of World Wildlife Fund founders Prince Philip and Prince Bernhard of the Netherlands, to reduce world population to below one-third present levels, remains the guiding policy and intention of the environmental movement.

It is an evil worse than Hitler, and has already claimed more lives, through denial of economic development, bans on life-saving substances such as DDT, and other premeditated actions of mass murder.

Doctors using cesium-131 radiochemical brachytherapy "seeds," to treat prostate and other cancers. The Cesium-131 has a significantly shorter half-life than the two other isotopes commonly used for brachytherapy, allowing faster delivery of therapeutic radiation to the prostate gland, reduced incidence of common brachytherapy side effects, and lower probability of cancer cell survival.

Radioisotopes: The Medical Lifesavers That Congress Is Suppressing

by Christine Craig

Part I
U.S. Radioisotope Production and Use

The use of radioisotopes for the diagnosis and treatment of disease is now a vital part of modern medical practice. Aside from a few simple treat-

The cost of the U.S. policy restricting radioisotope production and use can be measured in human lives lost. Reviewed here is the history of

another radioisotope, iodine-232. Tucker and Greene developed the first molybdenum-99/technetium-99m generator, and Powell Richards, also of Brookhaven, fostered its development for medical purposes. But in 1966, the laboratory bowed out of production, leaving the playing field open to two private companies, Mallinckrodt and

Join the Campaign To Save the U-233!

In the Winter 2009/2010 issue, Christine Craig outlined the devastating lack of medical isotopes in the United States and the deliberate Congressional actions to bury the nuclear feedstocks (inappropriately termed "waste") that should be used to supply valuable isotopes.

This letter from a retired national laboratory official lays out a plan to save and use these nuclear materials, and urges readers to contact their representatives to get behind a plan to save the U-233 for isotope use. The author's white paper, "Save the U-233! But How?," can be accessed in the links he provides in footnote 3 below.

To the Editor:

Thank you for Christine Craig's story on the history of isotope suppression ("The Medical Lifesavers That Congress Is Suppressing," www.21stcenturysciencetech.com/Articles_2010/Winter_2009/Isotope_Suppression.pdf). She has done a good job of capturing the history of uranium-233 and its potential benefits.

I was partly responsible for what she called the "highly publicized plans to extract the Th-229 from the U-233 before disposal" at the Idaho National Laboratory. I also tried unsuccessfully to use a small sample of the U-233 at Oak Ridge National Laboratory to recover enough Th-229 to complete the Phase III clinical trial for acute myeloid leukemia at Memorial Sloan Kettering Cancer Center. Though neither effort was successful, there may still be time to detour the down-blend train.

Congress terminated the project once before because of skyrocketing costs. Congress has incentive to do it again. Costs are still spiraling out of control. The latest estimates I have seen are approaching half a billion dollars.[1]

As for safeguarding the U-233, the Department of Energy was instructed in March 1997 to come up with a plan to place the U-233 in safe, permanent storage. The current estimated completion date of the U-233 Down-blending Project is 2021[1]—or 24 years later. It would be interesting to know if these ongoing delays in providing safe storage of U-233 are acceptable to the current Defense Nuclear Facilities Safety Board.

DOE is doing what Congress has directed it to do. So, calls to DOE to save the U-233 fall on deaf ears. It is Congress that must act to terminate this down-blending project.

To that end, I have asked my senators and congressman to include the following language in the FY2011 Energy and Water Appropriations Bill for the Department of Energy:

"The Secretary of Energy shall direct that the Uranium-233 Material Down-blending and Disposition Project at Oak Ridge National Laboratory be terminated and that the uranium-233 be promptly transferred to safe, secure, interim storage at another DOE site."

The delegation is willing to listen.

This action would detour the current disposal path but not necessarily change the eventual down-blending. This approach has several advantages. First, it eliminates the urgency to do the down-blending at ORNL and the half-a-billion dollar price tag. Second, transfer to another DOE site places the U-233 in safe storage in a five-year time span, instead of ten years. Third, DOE can consider an alternative disposition path. Namely, they could consider chemical down-blending rather than isotopic down-blending, and still ship the material to the Nevada Test Site for safe, permanent storage.

The precedent for safe, permanent storage of chemically diluted U-233 was set with the U-233 from the Idaho National Laboratory. As part of the down-blending process, it would be possible for private industry to cover the incremental cost of recovering the thorium-229. With chemical down-blending, the U-233 would not be irretrievably lost. At the time the country decides it wants to pursue a thorium fuel cycle, the material would be recoverable.

Fourth, by promptly removing the U-233 from Building 3019, ORNL can begin investing in its central campus, and create jobs for the future, rather than continue with dead-end disposition jobs.

Last, but perhaps most importantly, the U-233 remains the responsibility of DOE's Office of Environmental Management. This is critical because no other DOE Office is willing or able to accept the long-term liability for this material.

Transfer of the U-233 to another site will not be trivial or cheap. However, DOE is familiar with, and budgets for, transport and storage of Special Nuclear Materials. Also, retrieval of the U-233 from storage is currently part of the disposition plan. So, DOE has a precedent to guide them and a sounder basis for estimating its cost. In addition, costs for transport should be incremental and only a fraction of the current down-blend estimate.

This action doesn't eliminate the cost for final disposition. It does, however, eliminate the urgency to do the down-blending at ORNL. In which case, DOE's Office of Enviromental Management can take the time to implement a more cost- and resource-conscious approach to final disposition. This should reduce the burden on annual Environmental Management budgets for disposal of this material.[2]

I have encouraged U-233 medical isotope and thorium energy advocates to contact their representatives—especially those on the House Energy and Water Appropriations Subcommittee—to support inclusion of this language.[3] Political support from these advocates will be crucial for any chance of success.

John R. Snyder, Ph.D.
Retired (2009) Commercialization Manager, Idaho National Laboratory
Idaho Falls, ID 83404

Notes

1. John Eschenberger, Assistant Manager for Environmental Management, DOE's Oak Ridge Office, in a presentation before the Energy, Technology and Environmental Business Association of Tennessee, April 29, 2010.
2. My arguments in support of this action are detailed in a white paper entitled "Save the U-233! But how?" which I included with my letter to Idaho Senator James Risch, requesting action on termination of the U-233 Project at ORNL.
3. Frank Munger's Atomic City Underground Blog, posted August 18, 2010: Campaign to Save the U-233 Stockpile, http://blogs.knoxnews.com/munger/2010/08/ campaign_to_save_the_u-233_sto.html and EnergyFromThorium website, posted August 18, 2010: "Help Dr. John Snyder save the U-233!" http://energyfromthorium.com/

NEW EVIDENCE THAT LIFE MIGHT HAVE BEEN (OR STILL IS) PRESENT ON MARS

NASA/JPL/UA/Lockheed Martin

NASA's Phoenix Mars Lander provides evidence of life? Here, the spacecraft is depicted fully deployed, monitoring the atmosphere and reaching out to the soil

A new analysis of data collected by NASA's Phoenix Mars lander two years ago has led specialists to rethink the possibility that the red planet may indeed have been an abode of life. Thirty years ago, almost all the geologists, biologists, chemists, and planetary scientists involved with NASA's Viking landers concluded that life had not been present on Mars, because there was no evidence of organic material found in the soil. Organics, simply meaning carbon-based compounds, can be from either biological or non-biological sources. But without detecting organic material, most of the scientific community closed the book on Viking's life sciences experiments.

Now, scientists examining chemical data from the Phoenix polar lander find that perchlorate (chlorine and oxygen) is present in the Martian soil. It is known that chlorine, when heated, can destroy organic compounds, and the Viking experiment that was designed to indicate the presence of organic material, heated the Martian soil. Instead of thinking that the heating in their experiment may have corrupted the results, the scientists believed that the chlorine that Viking found was a contaminant from Earth, not native to Mars. The reason was that the ratio of the two isotopes of chlorine found on Earth, matched the isotopic ratio that Viking found in the chlorine on Mars. But the ratio of the isotopes of chlorine on Mars has not been determined yet, so, in fact, it is not known if the isotopic ratio of the chlorine on Mars is the same, or different, from that on Earth. Finding the answers to these questions will require intensive interplanetary study. (See "Isotopes and Life," this issue.)

As NASA astrobiologist Chris McKay explains, this is not "proof" that life did exist on Mars, but it could "make a big difference in how we look for evidence to answer that question." The lead author of the paper, to be published in the *Journal of Geophysical Research*, is Rafael Navarro-Gonzalez of the National Autonomous University of Mexico (UNAM) in Mexico City.

JAPANESE REACTOR WILL LAST 80 YEARS, TAKE 30 MONTHS TO BUILD

The Japanese government, the Toshiba Corp., and Mitsubishi Heavy Industries, Ltd., are now developing a next-generation light water nuclear reactor, with a high power capacity and a lifespan of 80 years. The project was undertaken after a two-year feasibility study, and the basic design of the reactors is expected to be completed by 2015. The new reactor design, which is 1,700 to 1,800 megawatts, will have an almost 50 percent larger power-generation capacity than the largest reactors built today, and will take less than 30 months to build.

Takanori Tanaka, executive director of the Institute of Applied Energy (IAE), who oversaw the study, said on Aug. 17, that it is viable to develop an advanced boiling water reactor or pressurized water reactor that has the world's highest utilization rate—in service 97 percent of the time over an 80-year life—by using uranium more highly enriched than is currently used. This would also reduce the amount of fuel used.

Japan is targetting sales to the United States, Europe, and Asia, where an expected 270 reactors will be replaced by 2050, after reaching 60 years in use, according to the report. Serious economic development would require 10 times that number.

One big city: South Korea's High Speed Train, the KTX, will be expanded to unify the nation, making almost all locations accessible within 2 hours.

KOREA HIGH-SPEED RAIL PLAN: ONE BIG CITY

The Korean Government announced its strategic plan for the Korean Train Express (KTX) high-speed networks, which will consolidate the transport grid. Korea's current KTX system, which connects the capital, Seoul, with the two major southern cities, Busan and Mokpo, will be expanded and filled out to a network of routes that will completely unify the country. "Eighty-four percent of the Korean public will be

able to use bullet trains enabling them to travel to 82 percent of all locations in the country in less than 90 minutes and 95 percent in less than 2 hours," according to Hong Soon-man, director of transport policy at the Ministry of Land, Transport, and Maritime Affairs. Thus, "The entire country will essentially become one big city."

The railroad expansion will be rolled out in stages between 2014 and 2020. Initial speeds will be 250 to 300 kph (155 to 186 mph) but will be enhanced to 400 kph (250 miles per hour). The government also plans to develop the railway industry into a new engine of growth, and build a new generation of bullet trains capable of travelling up to 430 kph by 2012, with plans to export them overseas.

China plans to build more than 200 nuclear plants in the next 20 years, creating an indigenous nuclear manufacturing capability.

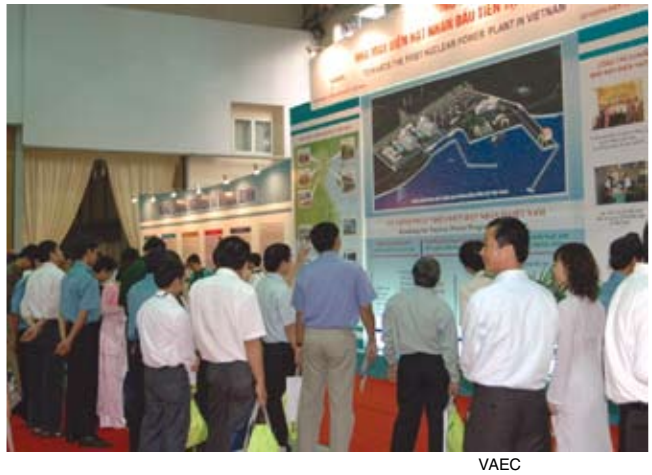
CHINA TO DOUBLE NUCLEAR CAPACITY WITH OWN MANUFACTURING BASE

China is expanding its own nuclear manufacturing base, to fulfill its aggressive program to double its nuclear generating capacity to 80 gigawatts in the next 10 years, and then to add an additional 120 gigawatts in the following decade (more than 200 plants, total).

For example, it was recently announced that China First Heavy Industries will be manufacturing the reactor pressure vessel for the first unit of the planned Xianning nuclear plant. This capability is critical, as there is a worldwide shortage of heavy forging capacity, and there is a multi-year waiting time in the West for reactor pressure vessel orders. The Xianning plant will be one of the first sited inland, not in the coastal regions, and will most likely be a Westinghouse AP1000 reactor. Westinghouse is already contracted to build four AP1000s in China.

The Westinghouse contracts all include a requirement that a certain percentage of the plant's components are to be built by local Chinese companies. At some point, China will license the technology from Westinghouse, and produce the nuclear plants entirely in-house. At the same time, China has designed its own nuclear plants, which, because they have no U.S. content, are not restricted by U.S. export laws. These have been sold to Pakistan, for example. One such indigenously produced plant, a CNP-600 (650-megawatt) pressurized water reactor, was connected to the East China Power Grid on Aug. 1. Another CNP-600 plant is under construction at the same site at Qinshan.

China is rapidly becoming self-sufficient in reactor design and construction. With 24 plants now under construction, and more about to start construction soon, it will rival the pace of the nuclear build in the United States in the 1970s, which was politically aborted in the 1980s, and never went beyond today's 104 operating plants.



VAEC

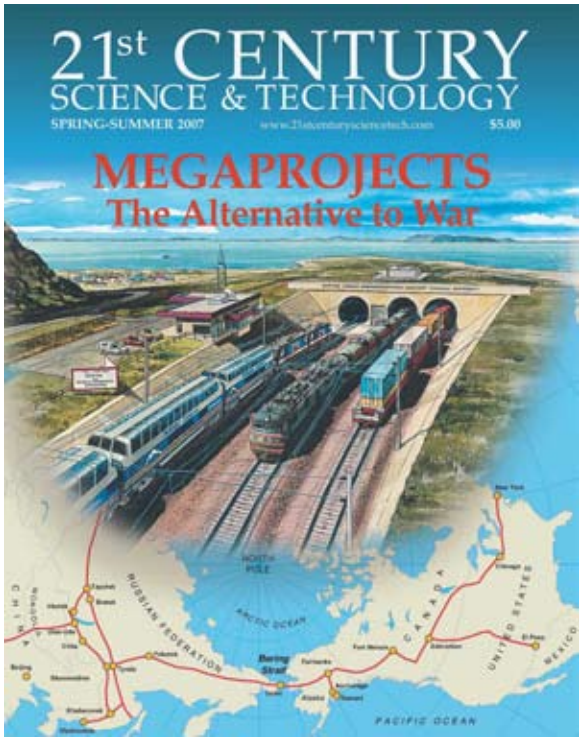
Vietnam has an ambitious program to train nuclear scientists and engineers, to run the eight nuclear plants that it plans to build by 2030. Here a 2006 Nuclear Power Exhibition in Hanoi, which drew 6,600 Vietnamese visitors, including 200 Parliament members.

VIETNAM PUSHES TO DEVELOP NUCLEAR LABOR FORCE

Vietnam, which is leading the countries of South East Asia in the race for nuclear power, has approved a $154 million plan to train and develop a skilled workforce for the nuclear power sector over the next 10 years.

The country has already decided to build two nuclear power plants in the central province of Ninh Thuan by 2020, with a total capacity of 4,000 megawatts, and six additional plants will be constructed in the central region through 2030. The two initial plants will be built by Russia, and other nations, including Japan, are competing to build the subsequent plants. In late August, a Japanese delegation, including the heads of the three largest Japanese nuclear construction firms and the three largest operating companies, visited Vietnam, and China signed a memorandum of understanding on nuclear cooperation with Vietnam.

"Atomic energy can also be used in the health-care sector, industry, agriculture and other economic sectors. Thus, there will be a shortage of human resources to work in



A rail tunnel across the Bering Strait, joining North America and Russia, is a crucial link in the World Land-Bridge project. Prince Philip's World Wildlife Fund wants to stop this development, by locking up the region for "nature."

the field," a government statement reported on Aug. 21. "The plan is expected to help Vietnam develop human resources in tandem with its atomic capacity."

Vietnam will seek to bring its university-level atomic energy studies into step by 2015, five years before any of the plants are operational. It intends to train 2,400 nuclear engineers, and issue 350 masters degrees and Ph.D. degrees for operating nuclear power plants, all within Vietnam. Two hundred engineers and 150 of the high-level graduates will be trained abroad. Vietnam will also train another 100 advanced degree holders to teach nuclear energy at educational institutions.

WHITE HOUSE REACTIVATES WWF SCHEME TO HALT BERING DEVELOPMENT

In 2009, the Obama Administration reactivated a 20-year dormant project, spawned by the World Wildlife Fund (WWF), to impose an international nature preserve on the Bering Strait, which would deter any infrastructure development on this key link in the world land-bridge. Moves are continuing this Summer, towards a "Beringian Heritage" lock-up of land and resources, and impoverishment of local people, to directly serve the geopolitical interests of London finance behind the environmentalist game.

The area under discussion involves millions of hectares of coastal Alaska and Chukotka, on the Chukchi and Bering seas. This is exactly the region planned for the development corridors of the proposed Bering Strait Tunnel, linking Asia and the Americas, in conjunction with the North American Water and Power Alliance program (NAWAPA).

The White House push for this WWF anti-development program comes under the auspices of the new U.S.-Russia Presidential Commission, established in July 2009, by Obama and Russian President Dmitri Medvedev. Its goals featured the task of advancing "efforts to protect our shared heritage and environment in the Bering Strait region," as the Commission states. This jargon harks back, word for word, to the 1990s World Wildlife Fund propaganda for "Arctic preserves." The WWF is one of only two non-governmental organizations with official observer status in the Arctic Council, which consists of all the nations of the Far North: Canada, United States, Iceland, Denmark, Norway, Sweden, Finland, and Russia.

Ho Chi Minh City Ministry of Natural Resources and Environment

A landfill in Ho Chi Minh City, where one garbage-burning plant produced just enough electricity to run itself.

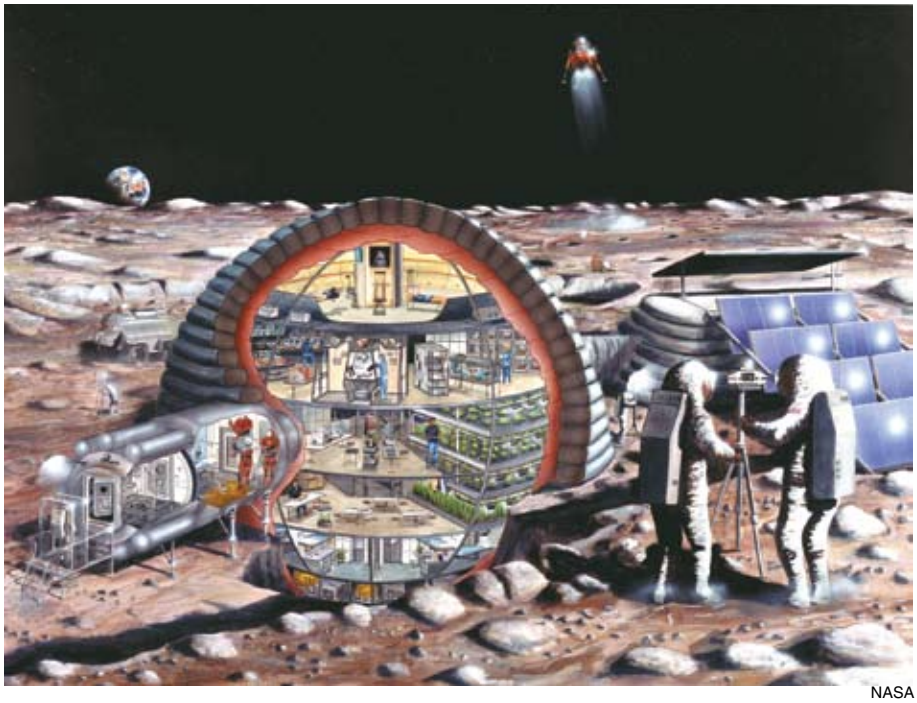
CHINA AND VIETNAM SHOW BIOFUELS ARE A FRAUD

Zhao Youshan, president of the China General Chamber of Commerce petroleum division, has repeated his demand that China end government-subsidized corn-ethanol production, the *Beijing Times* reported Aug. 10. Zhao first made this demand a month ago. He said that ethanol production has led to the rise of corn prices in China, turning the corn-exporting country into a corn-importer this year. Even so, the output of corn ethanol appears tiny when compared with the domestic demand for petrol, he says. Zhao heads China's largest membership association of private petroleum enterprises.

In Vietnam, they're asking "So, why would anyone invest in green electricity production to suffer losses?" Ho Chi Minh (HCM) City solid waste management chairman Nguyen Trung Viet estimates that to produce 1 kilowatt hour of electricity from garbage costs 20 cents (without subsidies), but costs only 4 cents with traditional power plants.

One landfill in Ho Chi Minh city that he operates has a $13 million plant, mostly built with a grant from the Netherlands, to produce electricity from garbage. That plant produced just enough electricity to run only the garbage burning plant itself!

Isotopes and Life:



NASA

Creating a synthetic environment for man on another planet requires an examination of the role of isotopes and life. Here, an artist's conception of a small artificial habitat on the Moon.

Considerations for Space Colonization

by Meghan K. Rouillard

Since the beginning of the Twentieth Century, the proper modern understanding of the physical principles which underlie a competent science of physical economy, has been most clearly expressed in terms of that development of a specifically human practice of physical chemistry, as by such as, most notably, both Chicago's William Draper Harkins, and, in a more elaborated form, as premised on Academician V.I. Vernadsky's scientifically crucial elaboration of the notion of mankind's efficient role as a species in an anti-entropically developing universe. The latter development, that of Vernadsky, expresses the essential characteristic of a universe which subsumes the three sub-spatial domains of the lithosphere, biosphere, and noösphere.

—Lyndon LaRouche,
"The Secret Economy," *EIR*, May 28, 2010

The science-driver policy of colonizing space, which physical economist Lyndon LaRouche has declared to be the indispensable mission for advancing mankind, will require many fundamental scientific breakthroughs—indeed, a decisive break from the empiricist so-called science of today. The work of figuring out how to support man's creative activity away from the surface of the Earth—the creation of "synthetic environments"—actually requires a rethinking of the concept of basic economic infrastructure, as LaRouche has indicated.

In this paper, part of a series being produced by LaRouche's "Basement Team," we address the question of the nature of isotopes from the standpoint of the issues raised in creating an environment on another planet. Although the isotope question may appear complex to the lay reader, it is just this kind of knowledge which will determine the future of mankind.

Vladimir Vernadsky's concept of the three distinct phase-spaces of abiotic, biotic, and noëtic, was qualified by him on the basis of experimental phenomena, such as the different nature of the chemistry inside and outside of a living organism. Vernadsky pointed to the work of Louis Pasteur as crucial in this respect, regarding the significance of the symmetry of molecules with respect to certain biological functions.[1] Vernadsky made bold statements in 1938, and at other

1. LPACTV, "Louis Pasteur: The Space of Life," and Louis Pasteur, "On the Asymmetry of Naturally Occurring Organic Compounds," in *The Foundations of Stereochemistry*, (Woodstock, Ga.: American Book Co., 1901).

times, that there was a similar difference in the way in which isotopes are used inside and outside of a living process. He wrote:

> Evidently, a shift (within certain ranges) in the isotopic composition (atomic weights) inside living organisms is a characteristic property of living matter. This has been proven for hydrogen, carbon, and potassium, and is probable for oxygen and nitrogen. This phenomenon calls for precise investigation. It is becoming more than probable, that a chemical element, upon entering a living organism, changes its isotopic composition.
>
> "The chemical composition of both types of natural bodies comes down to the same chemical elements—although it is possible that the atomic weights of some or all of the elements are shifted in living matter.[2]

The Ukrainian-Russian biogeochemist Vladimir Vernadsky (1863-1945) conceived of the universe as composed of three distinct but interacting domains, which he called the abiotic, the biotic, and the nöetic.

Vernadsky was to be proven right in his hypothesis of a unique "fractionation" (the shifting of isotopic ratios from a given standard) of the latter two elements (oxygen and nitrogen) in living matter, which is documented in various studies. Interestingly, at the time Vernadsky first uttered such hypotheses, more than 10 years prior to the above-quoted statement, the heavier isotopes of several of these elements had not even been discovered. Vernadsky considered himself a rigorous experimentalist, but his hypothesis about the fundamental distinction between living and non-living matter drove much of that experimental work, and he encouraged others to pursue such tracks of investigation.

What are isotopes, such that life could use them "differently"? Or, inversely, what is life, such that it requires a unique isotopic composition? These questions are analogous to the question provoked by Pasteur's work: What were the (at that time) hidden characteristics of what were thought to be similar molecules which caused life to distinguish between them? His work led to the science of stereochemistry, the study and significance of the orientation in space of molecules themselves.

What are the analogous hidden characteristics of isotopes which cause life to distinguish among them in a unique way, with respect to the environment in which the organism exists, or with respect to non-living matter?

What is life, such that it requires this? A pursuit of this question leads us in the direction of recognizing Vernadsky's point as being true: Life is a fundamentally unique state of physical space-time as compared to non-living phenomena. The particular ways in which isotopes interact with life are but one facet of this fundamental distinction.

We have reason to believe that fractionation would be caused

2. Vladimir Vernadsky, "Problems of Biogeochemistry II," *21st Century*, Winter 2000-2001, p. 20.

The French chemist Louis Pasteur (1822-1895), often referred to by Vernadsky, was first to discover the handedness of molecules produced in yeast fermentation.

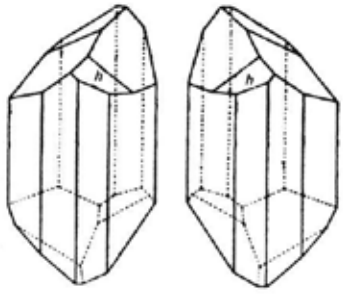


Figure 1
PASTEUR'S HANDED CRYSTALS OF TARTARIC ACID

Pasteur's sketches of left- and right-handed crystals of tartaric acid, found in the bottom of wine barrels. When dissolved in solution, where the crystal structure would have been destroyed, the rotation of polarized light by the solution occurs to the right or left, depending on which crystalline structure was dissolved. This indicated to Pasteur that there must be handed symmetry, not only at the crystalline level, but also at the molecular level.

A living organism is selective about which of these handed molecules it uses, unlike non-living processes. Pasteur found that only the left-handed form is produced in biological processes, such as fermentation, while in laboratory synthesis of the compound, equal quantities of left- and right-handed forms occur.

NASA

Crew members of Shuttle Mission STS-040 in 1991 using an in-flight collection system to take blood for use in investigating the influence of space flight on red blood cells. Many questions remain about how living systems will react under the different isotopic composition of other planets.

by something other than the masses of the isotopes. This may sound surprising, based on the simple definition of what an isotope is, i.e., an atom of the same element which has a slightly different mass. Many simply "physical" processes could show "preference" for an isotope based on its mass. Size is one consideration in determining passive diffusion through a membrane, for example. This question can be answered based on simple physical laws, depending on the membrane.

But, based on Vernadsky's view of Pasteur's work, we have every reason to think that the space-time inside of a living organism is more unique, and perceptive, if you will, than what is implied by a simple apparatus to describe the laws of interaction between bodies and membranes. Part of what we intend to do here is to show that isotopes are, in fact, much more complex little creatures, which are not simply different because they are a little more or less hefty. And we would expect this to be the case, since a living organism is much more perceptive than a scale.

British physicist J.J. Thomson (1856-1940) experimenting with beams of positively charged neon ions in 1913, speculated that some neon ions might have different masses.

If life requires a unique isotopic composition, which is determined by a unique type of selection of isotopes within the organism, as hypothesized by Vernadsky, it would be a significant concern to be taken into account, in making plans to create artificial environments on our Moon or Mars, where isotopic composition is by no means certain to be the same as found on Earth, even where similar elements are to be found. Let us explore a bit of what we've come to know about that multi-faceted little creature, the isotope, and how life may be interacting uniquely with it. Though we may not arrive at any concrete answers, these questions are the ones we should be confronting and directing experimentation towards, in intending to leave the surface of our planet, to re-create human society on Mars.

It should also be said, that a true unified field theory should aim to define phenomena such as electromagnetism, gravitation, chemistry, and more, based on how these phenomena act in relation to each of Vernadsky's three phase spaces.[3] The real prospect of space colonization makes this more than a simple academic pursuit, as we attempt to re-create an environment suitable for life on other planetary bodies. Knowing what isotopes "are" will require an experimental, but non-axiomatic study of how they interact with living matter. Those who have become acquainted with the mind of Vernadsky should concur that he would, most likely, be in agreement on this point. Let us begin by looking a bit at some of the initial paradoxes posed by isotopes, since their discovery.

The Shadows of the Isotope

In 1913, J.J. Thomson, in experimenting with beams of ions of the element neon (canal rays), deflected by electric and mag-

3. Sky Shields, "The Significance of Biological Research in Space for the Development of a Unified Field Theory," Submission to the National Research Council's Decadal Survey for Biological and Physical Sciences in Space, October 2009.

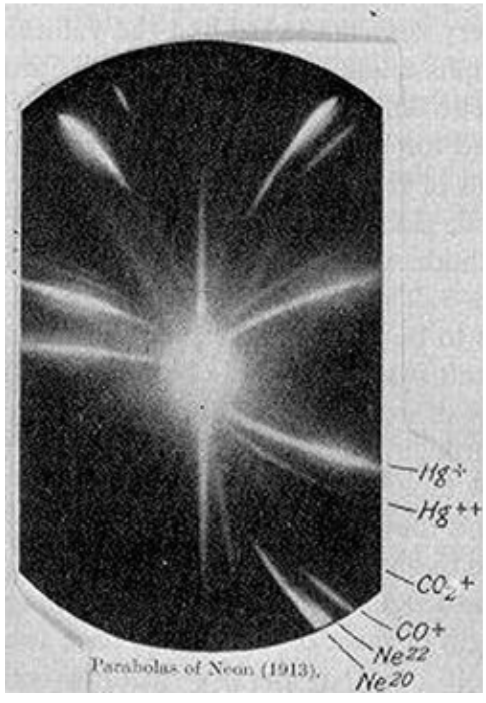


Figure 2
THOMSON'S PHOTOGRAPHS OF NEON ISOTOPES
This photographic plate, from one of J.J. Thomson's experiments, shows two different positions for neon ions, which are now known as the isotopes neon-20 and neon-22.

netic fields, noted that some of these ions were deflected differently, having different parabolas of deflection, as seen by their projections on a photographic plate. This led him to think that these various neon ions, previously assumed to be all the same, could possibly have different masses.

In 1917, the Chicago University-based physical chemist William Draper Harkins began to investigate what were pointed to as being very slight differences in the spectra emitted from different isotopes of lead, and a few other elements. The differences were so slight, that, at the time, he was not even confident whether there was actually a difference. Without commenting on that investigation per se, we can gain some insight from his hypothesis, that there could be another characteristic to the isotope, besides a simple increase in mass, which would account for the different spectral emissions—something related to the different "space arrangement" itself.[4]

University of Chicago physical chemist William Draper Harkins (1873-1951) did important experimental work on the structure of the atom, and was the first to demonstrate the slight differences in the spectra emitted from different isotopes.

> The fact that isotopes, with a constant value of P [protons], but with a variable value of b [neutrons], have almost exactly the same spectra, indicates that the non-nuclear electrons vibrate as might be expected, as if the positive and negative electrons [what he later was the first to call neutrons] were not present in the nucleus, that is as if it consisted of P positive electrons [protons] alone.... It might be expected, even if there is no effect due to the mass, that if the positive and negative electrons in the nucleus are not coincident, their space arrangement should cause a slight, though possibly unmeasurable effect upon the spectrum.[5]

So, Harkins figured that the simple mass increase contributed by uncharged neutrons would not change the spectral emission, but, a change in the orientation of the contents of the nucleus could. The usefulness of this statement is mainly that it introduces the idea that isotopes are not simply heavier or lighter, but that the change in structure itself could contribute to other kinds of differences, of the kind which would produce different emission spectra from different isotopes, for example.

This is not completely foreign to Pasteur's own hypothesis that different molecules of tartaric acid could actually interact differently with a living organism because of their spatial arrangement, or their symmetry, not simply based on the "stuff" they are made of. Outside of the living organism, such differences do not matter. Vernadsky thought this implied a unique state of space of the living organism itself:

> A chemical distinction between right- and left-handed forms of the same chemical compound, characterizes the state of the physical space, occupied by the body of a living organism, and its manifestation in the surrounding medium, in the biosphere.[6]

Perhaps we can not go so far as to claim to know what is being perceived by the organism, but symmetry seems to matter. This is an indication that life is different from non-life, even at the chemical level, which flies in the face of assertions that life could simply be built up out of the same "non-living chemicals." There is, in fact, a difference when we discuss chemistry in the living organism. But what about at the even more relatively microscopic level—at the level of the atoms which compose these symmetric molecules—isotopes? Vernadsky thought that this, too, was a phenomenon of a similar nature:

> Don't we have in this biogenic change of the atomic weight, one of the numerous manifestations of a sharp material and energetic distinction of the living matter and the inert, which are observed in all biogeochemical processes?[7]

The fractionation hypothesized by Vernadsky, even before much of it was experimentally demonstrated, does exist, and we will look at a few examples, which do not nearly encompass all the work which has been done in that vein. The other side of this question to begin to poke at, is how, or why, this occurs.

Isotopes, as noted above, are typically distinguished by mass, but processes inside living organisms seem to indicate to us that we are only perceiving one shadow of what the actual isotope is, in looking at mass per se. We already know that the organism can perceive qualities such as symmetry. In 1935, Vernadsky said that we should not "overlook the other physiological side of the problem, when it is possible to advance it, that is, the question of the mechanism of the action of the organism upon the isotopic mixtures of elements," being careful however not to put forward hypotheses about how this would occur.

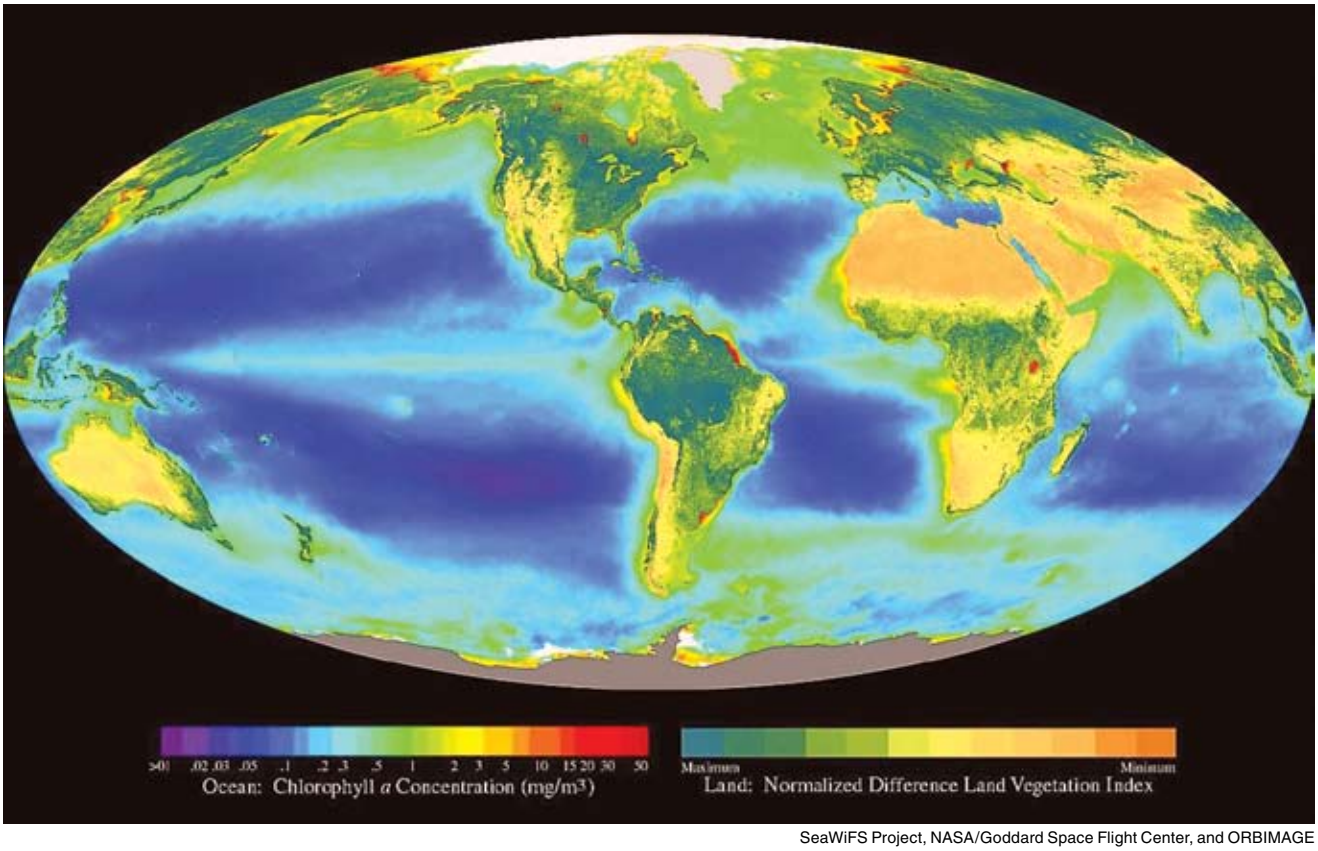
By no later than 1940, work on potassium fractionation in

4. Keep in mind, so as to make his statement more clear, that Harkins did not yet know of the neutron per se, but conceived of an atomic model which essentially did consist of neutrons, except that his neutrons were extra protons inside of the nucleus, orbited by electrons which cancelled out the charge of the protons.

5. William Draper Harkins, "The Spectra of Isotopes and the Vibration of Electrons in the Atom," *Proceedings of the National Academy of Sciences of the USA (PNAS)*, Vol. 3, No. 12, Dec. 1917, pp. 710-715.

6. Vernadsky, *Op. cit.* (Note 2). Also see, Vernadsky, "On the States of Physical Space," *21st Century,* Winter 2007-2008.

7. Vladimir Vernadsky, "On Some Fundamental Problems of Biogeochemistry," *21st Century,* Winter 2005-2006.



SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE

A composite image of the global biosphere, using data collected from September 1997-August 1998, showing the magnitude and distribution of global primary production of chlorophyll, both oceanic (in milligrams per cubic meter of chlorophyll) and terrestrial (normalized difference in the land vegetation index).

rats by A.K. Brewer,[8] known to Vernadsky, already explained fractionation, based on a kinetic mechanism, which is a model that would not have been completely new, since it implies nothing fundamentally different than considerations of how much energy is required to break a bond. Even early writings of Vernadsky, as in 1926, currently being translated,[9] show him hypothesizing that, even were the isotopic compositions of living and non-living matter the same, reasons of symmetry could account for some difference. This is also referenced briefly in Vernadsky's book *The Biosphere*:[10]

"It is very likely that isotopes and the symmetry of atoms play roles in the living organism which have not yet been elucidated," he wrote.

Although this thought is left unfinished, the point is, that Vernadsky was completely confident that there would be a distinction. So, in accord with his general outlook, let us open our minds to some of these questions, and some new and provoking experimental work which shows that the considerations involved are by no means so simple as they are commonly discussed as being.

'Mass-Independent' Isotope Effects

The term "mass-independent isotope effect" has a very specific technical meaning, which we will look into here, to some extent. It is said that a true study of mass-independent fractionation, or a shifting of isotopic ratios from a standard ratio that is not based on mass, can only be measured when looking at elements which have more than two stable isotopes; that when dealing with the fractionation of only two isotopes, or the deviation from some standard isotopic ratio, it can simply be stated that more of the heavier or the lighter isotope is being chosen; this is called mass-dependent fractionation.

Let's look at a couple of examples of what we mean by living processes using isotopes in a "different way," without having to show some variation among three isotopes which vary differently than with mass. It should become clear that the quality of the isotope being perceived by the organism is not simply its weight. Some experts in this field would agree that the organism is not using a scale to judge the isotopes upon entrance, but that bond strengths, for example, are affected by mass. We will not discuss this particular hypothesis much, since more provocative questions loom, even when dealing with so-called "mass-dependent" isotope effects.

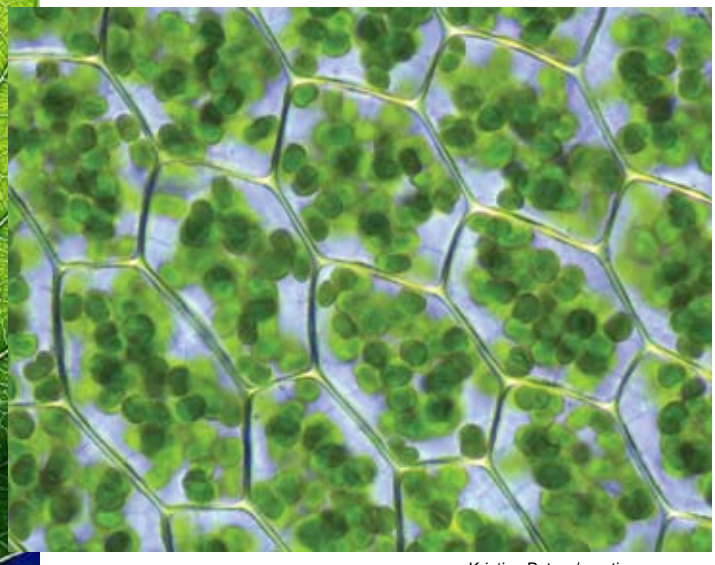
For example, specific tissues require unique isotopic compo-

8. A. Lasnitski, A.K. Brewer, "A Study in the Isotopic Constitution of Potassium in Various Rat Tissues," *Biochemical Journal*, January 1941; Vol. 35(1-2): pp. 144-51.

9. Vladimir Vernadsky, in "Work on the Biogeochemistry and Geochemistry of the Soils," Russian Academy of Sciences, 1992 (in Russian).

10. Vladimir Vernadsky, *The Biosphere* (New York: Springer, 1997).

Photosynthesis in plants varies in the uptake of carbon isotopes, with different parts of the plants having more or less carbon-12 or carbon-13. Seeds, for example, tend to be more enriched in carbon-13 than other parts of the plant.



Kristian Peters/creative commons

Plant cells of the moss Plagiomnium affine*, showing visible chloroplasts. Why do some plants take up heavier or lighter isotopes?*

sitions themselves. If it were simply a question of chemical bond yields acted on by enzymes which proceed more quickly with the substitution of a lighter for a heavier isotope, for example, then why would heavier isotopes be used at all? And on the flip side, heavier isotopes strengthen bonds based on their masses. But the point here is to question how the particular ratios are determined for the organism as a whole, without assuming that it occurs as a huge summing-up of individual kinetic and equilibrium effects, if only because isotopes have other, more interesting, ways of potentially interacting with living matter.

In photosynthesis, plants get rid of the heavier of the two main isotopes during respiration. What determines this is not simply which of them, by mass, passes more easily through the same membrane or pore. The prevalence of carbon-12 could possibly be explained this way, in what the plant takes up (more of the lighter isotope—called equilibrium fractionation), but the fact that the heavier isotope is preferentially removed during respiration, showing a reversal of which isotope "passes through," indicates that this is not so simple a matter.

As researchers on the subject noted in 2004,

> Recent experiments on intact bean leaves have shown a significant enrichment in ^{13}C [carbon-13] by about 6% in the CO_2 respired in the dark compared to leaf sucrose, indicating a substantial fractionation associated with respiration.[11]

Why is it that an overall enrichment in carbon-12 is required in plants with respect to their environment? The matter is not even this simple; looking at the relatively more specialized levels, further differences in enrichment are revealed. Different parts of plants show different concentrations of carbon-13 relative to carbon-12. Lipids, and leaves, in general, appear to be depleted even more in the heavier carbon isotope, while seeds are more enriched in it.

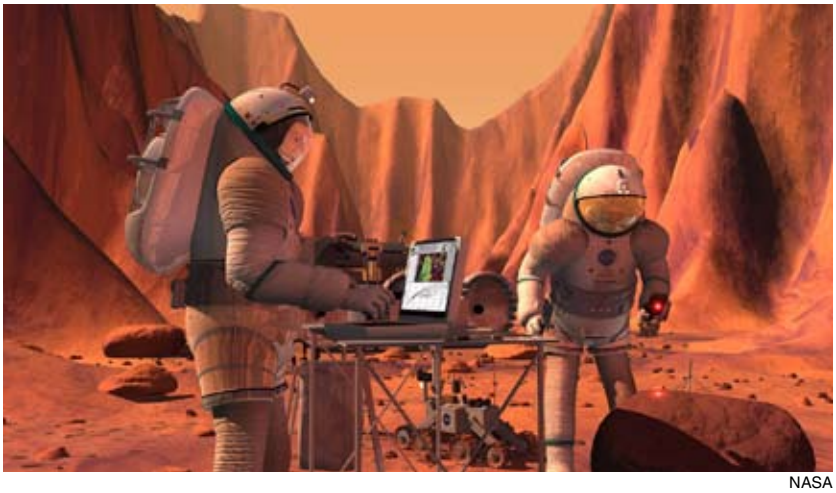
Oak Ridge National Laboratory

Uranium-reducing bacteria may be the cause of the different isotopic composition of some deposits of uranium ore. Here a species of metal-eating bacteria from the genus Shewanella*, shown here growing on a mineral of iron called hematite.*

11. E. Brugnoli and G.D. Farquhar, "Photosynthetic Fractionation of Carbon Isotopes," in *Photosynthesis: Physiology and Metabolism (Aarhus, Denmark: Kluwer Academic Publishers, 2004)*

Viking Orbiter Image Archive/NASA

The atmosphere of Mars, taken from low orbit by the Viking satellite. Because the Mars atmosphere (unlike that of Earth) is relatively transparent, down to the planet's surface, ultraviolet radiation has produced a different fractionation of some isotopes from that on Earth. We need to find out how this will affect the setting up of an artificial environment for man on Mars.



NASA

An artist's rendering of a polar mission on Mars, where crew members are assembling equipment.

It is even more generally the case that a given "isotopic diet" does not describe fractionation between different tissues and parts of animal bodies. Depletion in blood of the heavier iron isotope with respect to diet; calcium depletion in heavy isotopes in bones versus other tissues; potassium depletion in lighter isotopes in the bones of rats with respect to other tissues; enrichment of the heavier isotope of nitrogen with progression up the food chain and of the lighter isotope of iron—all these are examples of this phenomenon, and a good amount has been written on such particular studies. Mercury in different species of peat moss, from Argentina and Spain, shows, in one case, enrichment, and in the other, depletion, of two odd-numbered isotopes of mercury.[12] (This is technically considered a mass-independent isotope effect.)

Depletion of uranium isotopes in one kind of uranium ore deposit has shown significant depletion of one of the uranium isotopes, and the possible role of uranium-reducing bacteria is not to be ignored.[13]

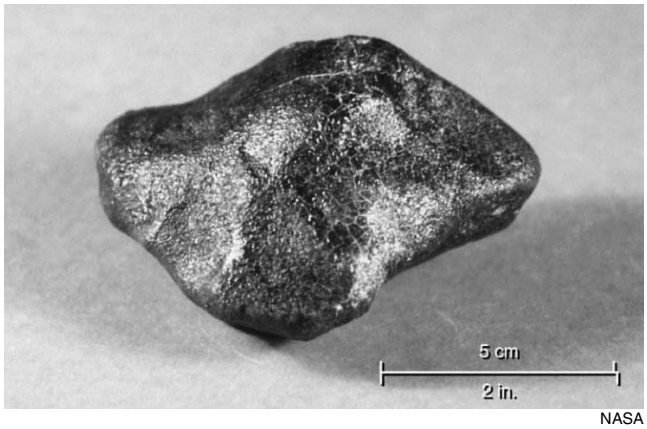
Here's another case of isotopes interacting in an interesting way with life: Experiments have been done on bacteria, in shifting them from water which is "normal" $H_2{}^{16}O$ to water, in which the hydrogen and the oxygen-16 are switched for deuterium and oxygen-18. Some of these *E. coli* bacteria showed a complete halting of growth for as much as 30 hours, when switched from normal, to isotopically heavy water; others showed significant morphological changes.[14]

Was it the weight of the water that caused this effect? As posed at the beginning of this section, some scientists today would explain these effects based on a secondary property of weight, the way in which the weight of the isotope affects certain bond strengths, reducing all but some actually "mass-independent" isotope effects to a simple kinematic model (this is called the kinetic isotope effect). But the question we are intrigued by, is how the overall desired ratio is deter-

12. Sanghamitra Ghosh et al., "Mass-independent fractionation of mercury isotopes in the environment," *Geochemistry, Geophysics, Geosystems*, Vol. 9, No. 3, March 2008.

13. "Uranium isotopes are not invariant, researchers show," http://www.news.illinois.edu/news/07/1023uranium.html.

14. E. Borek and D. Rittenburg, "Anomalous growth of microorganisms produced by changes in isotopes in their environment," *Proceedings of the National Academy of Sciences of the USA*, Vol. 46, No. 6 (June 15, 1960), pp. 777-82.



NASA

A piece of the asteroid Vesta. So far, investigations of the isotopic composition of Mars, Earth, the Moon, and the asteroids show that they seem to be similarly enriched in the heavier oxygen isotopes, compared with data found for the solar wind.

mined, and that without simply assuming that it occurs as a summing-up of millions of individual bonds, which are more or less able to be broken by enzymes, for example.

When not in a pure heavy-water environment, water molecules bound to plant cells show a relative depletion of deuterium with respect to a given source of water, seemingly using the deuterium in a precise fashion, if it's not preferentially being released (the model of equilibrium fractionation would not explain that occurrence). Where is the rest of the deuterium going? Why is it more useful somewhere else in the plant?[15]

Returning briefly to the subject of the work of Pasteur, and to the subject of whether the isotopes are simply "more or less" of the same element, consider the fact that the lighter or heavier isotopes may serve totally different functions. Amino acids are generally considered to be entirely left-handed molecules, and sugars, right-handed. However, significant cases of right-handed amino acids, though relatively much less abundant, as is the case with heavy isotopes, do exist, and they play a unique role.

One example is an anomalous right-handed version of aspartic acid found in the brains of rats, chickens, and humans, which is present in large amounts during developmental stages, and then rapidly decreases to only trace amounts during adult life. Perhaps the analogy is not exact, but it raises the right question: whether the more trace isotopes are playing a completely unique role, outside of contributing more or less mass to a chemical bond.[16]

We can already see that paradoxes arise in explaining the transmission of only two different isotopes across a membrane (that a simple preference for heavier or lighter is not always shown). There was also the role of a given "water environment" in inducing morphological changes in an organism through a switching of isotopes. What is the precise use of a heavy isotope, such as deuterium, in plant water?

These examples, although only dealing with two isotopes, would tend to lead us to believe that the matter is not so simple as heavier or lighter being "preferred" or "better for you." The heavier isotopes are generally much less abundant than the lighter ones, so any enrichment in heavy isotopes occurs on a very small scale—another example of a weak force at play, perhaps similar to the crucial role played by low-intensity radiation. It's likely the case that some instances of "mass-dependent fractionation" are simply processes which we do not yet understand, but will tend to explain based on a preference for lighter or heavier through a sieve-like mechanism. Such an explanation coheres with the simplest definition of what an isotope is, though, as an explanation, it leaves much unexplained.

Before moving on to another aspect of this problem, consider already what some of these considerations mean for colonizing a planet like Mars. In 2004, the NASA Genesis mission was deployed to investigate the isotopic composition of the Sun as compared to other planetary bodies. Interestingly, Mars, Earth, the Moon, and the asteroids seem to be similarly enriched in the heavier oxygen isotopes, as compared with what data were found for the solar wind, and the Allende meteorite, which is thought to contain some of the oldest material in the Solar System.

Nitrogen, another element crucial for life, is enriched 4.5 times more in the heavier isotope on Jupiter's moon Titan than on Earth. How would life be able to adapt to such conditions, in an environment depleted of heavy oxygen isotopes, or significantly enriched in heavier nitrogen isotopes?

In June 2008, the Phoenix Lander on Mars found the soil to have substantial amounts of magnesium, sodium, potassium, and chlorine, all elements important for plant growth on Earth. But what is the isotopic composition of these elements on the Martian surface? How would plants grown on Mars be affected if the isotopic composition of the soil were significantly different from that on Earth, and how would we compensate for that difference, if needed? An initial glance at the role of isotopes in life has shown us that such factors are not to be overlooked.

Fractionation of Planetary Atmospheres

Other interesting examples of mass-independent fractionation do occur in cases where there is a clear variation between two isotopes, from proportions of them increasing or decreasing with mass. A much studied case, is that of ozone, where

The fractionation of isotopes of sulfur (left) in rocks and magnesium (right) in photosynthesis is still under investigation, with speculation as to the causal mechanism.

15. D. Yakir, M. Deniro, et al., "Isotopic Inhomogeneity of leaf water," *Geochim et Cosmochim Acta*, Vol. 53, pp. 2769-73, 1989.

16. Uwe Meierhenric, "Minority Report: Life's Chiral Molecules of Opposite Handedness," *Amino Acids and the Asymmetry of Life* (Berlin: Springer, 2008).

NASA/JPL/MSSS

A midsummer storm in the northern hemisphere of Mars. The seasonal enhanced heating leads to the release of water vapor into the atmosphere, and the temperature differences create winds that mix the atmosphere and create waves of clouds that swirl around the polar cap.

among oxygen-16, oxygen-17, and oxygen-18, there is a spike in the amount of oxygen-17 present in ozone molecules, relative to what the expected enrichments would be if they depended on a scaling with mass. There is an almost equal enrichment of oxygen-17 and oxygen-18, and a relative abundance of the totally asymmetric ozone molecule $^{16}O^{17}O^{18}O$. Reasons related to the elusive quantity of "electron spin," and a resulting asymmetry of the molecules, are hypothesized by most current scientists as being causal factors.

Also, the role of photolysis, or ultraviolet radiation, in producing a kind of mass-independent fractionation of sulfur in rocks from the Archean Earth atmosphere has been posited, through a type of resonance which the radiation has with certain molecules, which can be different based on isotopic make-up. Each of these cases deals with three or more stable isotopes, so a depletion or enrichment of only one, or of two evens or odds, is what is called a mass-independent fractionation.[17]

In general, there does not seem to be consensus on the matter of how atmospheric fractionation occurs, as is stated in one recent article:

> Currently, in spite of fifteen years of intensive experimental and theoretical investigation after the first observation of a chemically produced mass-independent process, the mechanism that is responsible remains unidentified.[18]

You might protest that these are not living processes, so the hypothesis about the significance of mass-independent isotope fractionation in life does not fit. Admittedly, Vernadsky realized that even processes which are non-living can have a unique kind of fractionation with respect to the surrounding space, mostly gaseous phenomena under high temperatures and pressures.

So, the answer to our question is not simply showing that inside of the living organism, fractionation does not depend on mass, as though that alone made it unique. Then again, the question can be asked whether atmospheric fractionation on Earth, for example, can really be referred to as the result of completely non-living processes: Vernadsky himself noted that the biosphere extends up to the stratosphere. Also, the oxygen, carbon, and nitrogen cycles involve a biogenic migration of atoms which, according to one estimate, has a cycling of oxygen atoms in the atmosphere through living matter and back into the atmosphere once every couple of thousand years.[19] The unique isotopic effects produced in the atmosphere are ultimately intimately connected with the creation of the atmosphere by life.

But aside from that question in particular, this line of thought has already brought us to an important consideration regarding our future colonizing of other planets. Think of the question regarding the nature of the Martian atmosphere. Researchers looking at similarities between the Archean Earth atmosphere and the Martian atmosphere have pointed out that the photolysis which created fractionation of sulfur dioxide on Earth years ago in a low oxygen atmosphere, a result of UV radiation, is active on Mars all the way down to the surface, and produced a similar fractionation of sulfur isotopes there, that is still active:

> There are major differences between the Martian and terrestrial atmospheres. The most obvious difference is that water photolysis is important all the way to ground level on Mars; this is due to the relative transparency of the Martian atmosphere.[20]

How will this kind of fractionation affect our efforts to create an artificial environment on Mars, with compounds such as water vapor (preferentially over heavy-water vapor) being split all the way down to the surface? How will this type of fractionation

17. A.A. Pavlov, and J.F. Kasting, "Mass Independent Fractionation of Sulfur Isotopes in Archaen Sediments: Strong Evidence for an Anoxic Archaen Atmosphere," *Astrobiology*, Vol. 2, No. 1, 2002.

18. Mark H. Thiemens, "Mass-Independent Isotope Effects in Planetary Atmospheres and the Early Solar System," *Science*, Vol. 283, 1999.

19. Eugene Rabinowitch and Govinjee, "Photosynthesis," http://www.life.illinois.edu/govindjee/photosynBook.html

20. C. Miller and Y. Yung, "Photo-induced isotopic fractionation," *Journal of Geophysical Research*, Vol. 105, No. D23, 2000

affect the atmosphere which we create in its initial phase, as well as chemical compounds more generally?

'Spin': A Purely 'Physical' Quantity?

The special role played by magnesium-25 in photosynthesis is a much-touted case. This isotope's unique "spin," as mentioned, a quantity made hard to understand because of the obscure nature of quantum mechanical language, is hypothesized by many current scientists as being causal. The presence of this isotope has been shown to speed up the rates of formation of ATP (adenosine triphosphate) in photosynthesis when it is present in a specific enzyme.[21] Rather than getting into the technicalities of how this is supposed to work, let us look instead at some recent experimental work, not directly related to magnesium isotopes of photosynthesis, but work which is very interesting, keeping in mind Vernadsky's initial provocation that chemical processes within a living organism will be different from chemical and physical phenomena which we observe outside of that context.

Electron spin, and its ability to be affected by different isotopes of the same element, is usually discussed as possessing a type of resonance with magnetic fields. The concept of "spin" is also carried over from atomic electron to nucleus. For example, MRI/NMR (magnetic resonance imaging/nuclear magnetic resonance) imaging technology exploits the weak magnetic characteristics of some isotopes. But does spin itself simply refer to the state of an atom which is determined by, and determines, purely "physical" reactions? Recent experimentation has demonstrated the interesting phenomenon of "spin-polarized electrons" (some kind of coordination of spins) being "asymmetrically scattered" after interacting with films of chiral (left/right-handed) molecules.

As one researcher noted:

> A successful observation of electron optical dichroism (not rotation per se, as occurs with Pasteur's experiments with polarized light, but "spin-dependent attenuation" [a kind of loss of intensity or scattering—MKR] was eventually achieved by enhancing electron scattering through the addition of a ytterbium atom to camphor-based organic molecules to form (x compound) and analogous compounds.... I express my admiration for this elegant experiment. Other experiments have since been done to observe the asymmetric scattering of polarized electrons by organic films of thin chiral molecules. As of this writing, I am not aware of experiments that have observed the electron analogue of optical rotation. The preferential interaction of spin-polarized electrons with chiral molecules has attracted attention....[22]

While the details of how these experiments are carried out are important,[23] and have not been discussed in depth here, for our purposes, the significance of this, admittedly hard-to-conceive-of experiment, is that of the interaction of the quantity of spin with that of molecular chirality (handedness), which Vernadsky and Pasteur pointed at as being a unique characteristic of biological chemistry, its preference for and creation of these molecules. Many mass-independent isotope effects are explained based on spin numbers and "magnetic moments" of isotopes, including inside of the organism. But here is already an indication of a potentially unique "resonance" of electron spin, and chiral molecules, which we know to be characteristic of life.

Isotopes and Molecular Chirality

So, after all this, the question remains: what is being "perceived"? Mass? Spin? The spectra of the isotopes? How about the symmetry of the molecules? Which of these characteristics is the analogue to Pasteur's isomers (compounds with the same molecules, but different structural formulae) for isotopes? Perhaps we can not answer this question until more experimentation is done, but it is clear that isotopes, and living things, interact in a way which still remains hidden to us, but which does lead the mind in the direction of recognizing the interaction as very unique. However, one of those particular quantities may have caught your eye: the symmetry of the molecule itself.

We know this was Pasteur's focus, but what could this have to do with isotopes? The anomalous abundance of the completely asymmetric $^{16}O^{17}O^{18}O$ ozone molecule was referenced briefly, but it is sort of a step removed from life (although we will not assert that the atmosphere as a whole is non-living, as it is largely produced by life). In fact, more direct work has been done recently with respect to this asymmetry of molecules as a result of an isotopic substitution, creating a different notion of chirality.

In a work whose translation is pending, Vernadsky indicates that there should be something beyond molecular symmetry as a unique indicator of life's physical space-time, at the atomic level. He seems to imply that, even were there similar isotopic compositions between living and non-living matter, we should still assume there would be a difference, related to symmetry. What could this mean? This author would be inclined to think Vernadsky is discussing the possible significance of asymmetric molecules which contain both isotopes, or "isotopomers."

And in fact, some recent experiments have been done by substituting, for example, a carbon-12 for carbon-13 isotope in a compound which, when it typically reacts with another specific compound, produces a totally racemic mixture of molecules, or, in other words, handed molecules where there is generally a 50/50 abundance of each isomer (the normal symmetrical molecules discovered by Pasteur).[24] This experiment was done by reacting pyrimidine-5-carbaldehyde, and diispropolzinc, which created an enantiomorphic excess in the resulting zinc alkoxide; similar results were also shown for other reactions.

So, it has been shown that this ratio can be shifted through the "doping" of the catalytic compound. Here is another possibly unique role of isotopes in the living organism. It is not clear if any study has been done to determine the abundance of these new isotopically "chiral molecules" in life, but it is very intriguing to consider based on the uniqueness of handed mol-

21. J.R. Black, "An experimental study of magnesium isotope fractionation in chlorophyll-a photosynthesis," 2006, http://www.escholarship.org/uc/item/8x5346hj

22. "Chiral Asymmetry: The Quantum Physics of Handedness," in Mark P. Silverman, *Quantum Superposition: Counterintuitive Consequences Coherence, Entanglement, and Interference* (Berlin: Springer, 2008).

23. http://www.uni-muenster.de/Physik.PI/Hanne/chiral.html

24. Tsuneomi Kawasaki, et al., "Asymmetric Autocatalysis Triggered by Carbon Isotope Chirality," *Science*, Vol. 324, p. 492, April 2009.

ecules in life, as we have continued to emphasize, and a potentially unique and even catalytic role in forming these compounds by isotopically asymmetric molecules themselves, which life could potentially create. Does the overall fractionation in a living thing require a certain number of these new chiral structures?

Radioactive Potassium on Mars?

In an adult male, there are about 140 grams of potassium, of which a small, but powerful portion is the radioactive isotope of potassium, which produces, in total, about 80 decays per minute.[25] This isotope is small in abundance, but potentially has played a very important role in evolution, with seven times more of it being present 3.5 billion years ago, its action largely occurring within cells.[26] What is its role, in general, in human, animal, and plant physiology? Vernadsky knew of the work of the Dutch researcher Zwaardemaker, who did experiments where he pumped salt solutions through eel and frog hearts, claiming to have "revived them," due to the presence of radioactive potassium, and salts of other radioactive isotopes. While we cannot speak to the validity of this claim, or the precise role of radioactive potassium in the body, there is every reason to classify this, as well as the general phenomenon of isotope fractionation in the body, as a powerful, but weak force.[27]

But, again, we are confronted with another consideration which has implications for our colonization of Mars. Recent studies have been done indicating that there is possibly a direct impact upon nuclear decay rates based on the changing Earth-Sun distance throughout the year, in experiments done on radioactive isotopes of silicon, radium, and chlorine. An annual modulation in decay rates taken over 15 years, in some cases showed this correlation,[28] and similar experimental results were found in putting other decaying samples into rotating centrifuges—potentially related, since this could mimic gravitational effects.

In asking ourselves how we will support healthy humans on Mars, these considerations are crucial; even if only hypothetical, they indicate the kinds of problems we will need to consider. What if the decay of potassium-40 in the body is less on Mars, let alone if there is less of it overall? What is its role in the human body, and how would a change in its decay rate affect that? Would Martian soil need to be enriched in potassium-40 to compensate? This is the kind of thinking which shows how intrinsically linked the science of physical economy and physical chemistry are, in fact.[29]

Calls for Further Experimentation!

We see paradoxes in isotope fractionation which indicate to us that there are clearly characteristics of the real thing we refer to as "the isotope" other than mass. What facet of the isotope does the living organism perceive, or require? Is it some kind of required symmetry, as seems to be the case with Pasteur's isomers? While we may not have an answer, at least we can say that some of these questions have led us in the right direction, elevating our conception of what the interaction could be.

So-called "mass-dependent" isotope fractionation would seem to indicate, that inside of the living organism, processes are occurring according to simple kinematic or equilibrium laws, such as diffusion across a permeable membrane. However, Pasteur has led us to believe that there is a something other than a simple physical or chemical space inside of a living thing, which is why mass-independent isotope fractionation, particularly if it is symmetry-driven, is cause for excitement, and definitely calls for new modes of experimentation. It seems to be a field of experimentation avoided by biologists, who perhaps feel the shadow of Alexander Oparin towering over them, urging them to believe, despite Pasteur and Vernadsky, that life is not a unique and higher phase space, than the non-living domain. (The only explicit references in a scholarly article to "mass-independent-fractionation" in life found by this author, are the examples of magnesium-25, and the varying compositions of mercury isotopes in peat.) It were also a very good idea to do as Vernadsky wished: to examine isotope fractionation for all elements in living organisms, not just the most abundant ones.[30]

Although it seems that there are more questions than answers available to us, we have every reason to believe that Vernadsky's insistence on the distinction of the three universal phase-spaces will be vindicated in the domain of isotope fractionation and usage within the living thing. More focussed experimentation, with an eye towards Vernadsky's hypothesis, is long overdue!

This initial investigation of isotopes and their relationship to life is an important aspect of considerations we must take into account in planning to colonize space, if we wish to do it successfully. In such an endeavor, ideological approaches to questions about life as such will be of no help at all, as we attempt to try to keep humans alive on the Moon and Mars, for starters. The living organism does not exist independently of a whole array of relatively weak forces, including cosmic and electromagnetic radiation,[31] universal gravitation, and the unique isotopic composition of its environment, from which relatively small enrichments of already sparse isotopes are produced. Attention to such relatively weak forces is what will put us in the best possible position for supporting the seemingly weakest, yet truly most powerful force, human creativity, on Mars.

The author is a member of the LaRouche "Basement" Research Team. She can be contacted at meghan.roo@gmail.com.

25. "Exposure of the population in the United States and Canada from natural background radiation," National Council on Radiation Protection and Measurement; NCRP 96 (Bethesda: 1987).

26. F. Moore and K. Sastry, "Intracellular Potassium: 40K as a primordial gene irradiator," *PNAS*, Vol. 79, No. 11, June 1982, pp. 3556-59.

27. James Muckerheide, "Time To Tell the Truth about the Health Benefits of Low-Dose Radiation," *21st Century,* Summer 2001.

28. Jere H. Jenkins, Ephraim Fischbach, et al., "Evidence for Correlations Between Nuclear Decay Rates and Earth-Sun Distance," August 2008; arxiv.org/pdf/0808.3283v1; and He Yujian et al., "Changes of decay rates induced by mechanic motion," *Science in China,* Series B: Chemistry (Berlin: Springer, 2008).

29. At this point, it is appropriate to reconsider the quotation from Lyndon LaRouche, "The Secret Economy" cited at the outset of this report.

30. "We are faced with a general problem. Is the change of a chemical element with a different atomic weight by the life process restricted to some new chemical elements, such as hydrogen and potassium, or is this a phenomenon common to all organisms and all the chemical elements?" Vernadsky, *Op. cit.* (Notes 2 and 7).

31. Oyang Teng, "Onward to Mars: The Triumph of the Weak Forces," *21st Century*, Spring 2010.

Whole-Body Magneto-Therapy Speeds Wound and Disease Healing

by Prof. Bruno Brandimarte

Above: the All Body® apparatus developed by Brandimarte to deliver magneto-therapy. At left is rat bone tissue healing after experimental treatment.

The use of magneto-electric fields for non-orthopedic ailments goes back more than 30 years. From the time that magneto-therapy began to be used for rehabilitation and post-traumatic treatment, beneficial effects were noted also on inflammatory ailments, bacterial infections, vasculopathies (of various origins), fluid retention, and on the general condition of patients afflicted with viral infections such as hepatitis, and later, HIV.

Over the years, there has been a massive increase in the use of magneto-therapy in physiotherapy and orthopedics, specifically in the prevention and cure of retarded fracture consolidation. Many types of research were undertaken. The Europeans focussed especially on various kinds of arthropathies (joint diseases), but the entire world tried to gain a better understanding of the interaction between magneto-electric fields and living matter.

Scientific works by various authors (the most significant of which are referenced in a brief bibliography below) showed that this interaction stimulated some fundamental metabolic functions.

In the process of their pioneering work on bone formation in induced tibial fractures in rats, Prof. G. Marinozzi and this author began to notice that magneto-electric fields not only accelerated the formation of bone callus (the healing tissue in a fracture), but also increased the resistance to infection of the animals being treated, compared to non-treated controls.

In the attempt to find an explanation, experiments were done subjecting human lympho-

Dr. Bruno Brandimarte is a nuclear physicist and professor in the faculty of medicine at the University of Rome Tor Vergata, where he works in collaboration with Prof. Maurizio Monteleone, the director of the Orthopedic Institute; with Radiology and Diagnostic Imaging Professor Ignazio Caruso; and Professor of Experimental Medicine and Biochemical Sciences Roberto Testi. He is also director of the master's program in using physical means in conjunction with pharmacology at the University of Aquila; a professor in the master's program of the postural system at the University of Rome, Department of Experimental Medicine and Pathology; and a professor of applied biophysics at the International School of Medicine of the International Foundation Fatebenefratelli of Rome.

Brandimarte received his degree in nuclear physics at the Enrico Fermi Center in Rome, where he developed a biological model for the application of physical forces. This article was adapted from his scientific papers and translated from Italian by Richard Sanders.

cyte cultures to magnetic fields, with the effects reported in the works referenced in the bibliography below.

Studies of the formation of bone callus led to the discovery that the application of different types of fields had different effects. For example, an alternating sinusoidal field caused an increased rate of tissue growth (verified in a separate experiment on the rate of fibroblast reproduction), while the semi-sinusoidal field with a double half wave, caused microangiogenesis (the process of developing new blood vessels), Table 1 and Figure 1.

These experiments clearly showed that magneto-therapy could be applied with good results in various other fields of medicine besides orthopedics and physical rehabilitation.

Notable progress was made from a clinical standpoint, even though all the biological mechanisms were not yet completely understood. Significant results were obtained when magneto-therapy was used along with standard pharmacological therapies to treat various pathologies, especially in mitigating the side-effects of standard protocols. For example, low-intensity, anti-inflammatory signals were applied for cervical arthrosis, with repeatable sedative effects—whereas high-intensity signals caused states of excitement.

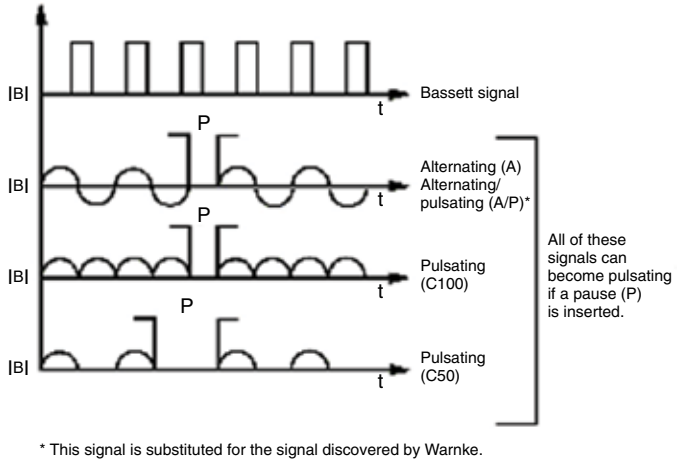
Next we wanted to tackle less localized problems, such as the spinal marrow, and therefore we studied technical systems which would deal with larger volumes. We began to use magnetic induction technologies delivering low power but over a large spatial volume, rather than just indiscriminately increasing magnetic induction intensity. This led to the best results when treating systemic pathologies, while virtually eliminating contraindications.

We recommend magneto-therapy as a primary co-adjuvant in association with standard pharmacological therapies, alerting the relevant physician that the effect of the pharmaceutical is usually enhanced (such as during chemotherapy) and should be monitored, because the patient usually becomes more capable of tolerating the therapy, and as the magnetic- or electric-field therapy takes effect, the pharmacological dosages can be gradually reduced.

Table 1
DIFFERENT FIELDS LEAD TO DIFFERENT EFFECTS

Type of Field	Intensity 5-20 gauss	Intensity 30-50 gauss	Intensity >60 gauss
A	Anti-inflammatory* Sedating	Anti-inflammatory** Encourages cellular reproduction*	Encourages cellular reproduction** Hyperemia*
A/P	Myorelaxing	Increased diuresis (kidneys)	Muscular tropism
C100	Sedating** Microangiogenesis*	Microangiogenesis**	Microangiogenesis*** Hyperemia**
C100/P	Myorelaxing		
C50		Local liquid intra-cellular mobility	Local liquid intra-cellular mobility

Notes
* Phenomenon perceptible but of low intensity
** Phenomenon clearly present but of medium intensity
*** Phenomenon dominant and of high intensity



* This signal is substituted for the signal discovered by Warnke.

Figure 1
FUNDAMENTAL SIGNALS AND THEIR PRINCIPAL BIOLOGICAL EFFECTS
The principal effects of sinusoidal or derived magneto-electric signals.

The All Body® Apparatus

The aforementioned research led us to design a new apparatus which we called "All Body," because it can treat the whole body using a method which is completely new, and which has been used successfully on the following:

- Immunosuppression
- Immunosuppression resulting from chemotherapy and radiotherapy
- Post-cancer surgery treatment in support of chemotherapy and radiotherapy
- Immunosuppression caused by HIV and full-blown AIDS
- Hepatitis and hepatopathologies
- Herpes zoster
- Fibroids
- Autoimmune diseases
- Rheumatoid arthritis
- Muscular dystrophy
- Generalized arthrosis
- Diabetes
- Diabetic ulcers
- Vitiligo and scleroderma
- Burns, wounds, and bedsores
- Fluid retention
- Renal insufficiency resulting from high doses of chemicals, cortisone, and pharmaceuticals
- Neuralgia, ischialgia, lumbago, paresis
- Age-related neurological disturbances.

The All Body® method consists of immersing the entire body in a low-intensity magneto-electric field for long periods of time, with the utmost regularity (daily treatment for at least 45 days).

The Evolution of Magneto-Therapy

In the 1970s, C.A.L. Bassett, with earlier French experiments on bone healing in mind, asked Columbia University technicians to design a machine capable of generating a current near the bone, without using needles.

The machine they designed used oppositely wound solenoids to induce a current with an average value greater than zero in the region in question; the geometric arrangement of the applied solenoids was of fundamental importance for achieving the desired effect (Figure 2).

In the second half of the 1970s, Dr. Ulrich Warnke of the University of Saarland, conducted another type of magneto-electric field experiment. The hypothesis on which he based his experiments, was that varying the potential of a cellular membrane around a normal value, even over a very narrow range, for example 100±1 mV), would facilitate and accelerate the entry and exit of polarized ions in the cell (Figure 3). To get this effect, Warnke used sinusoidal signals, which later proved to have an excellent effect in stimulating the metabolic-nutritional aspects of cell function. Thus Warnke took advantage of the pump effect—relative to a type II (paramagnetic) conductor—and of the fact that if subjected to a variable magnetic field, a polarized electrolytic membrane, unlike a copper conductor, will not take on an average potential value of 0 (of induced electric charge), but charges will accumulate on both sides of the membrane, creating a difference of potential.

The phenomenon described, in addition to its metabolic-nutritional aspects, has a significant influence on the transport of the active agent of a drug into the cells—for example, increasing the amount of a drug reaching certain regions, such as those in the brain. That is, the magnetic field acts as a catalyst for some drugs.

Between the close of the 1970s and the beginning of the 1980s, this author noted a tendency to interpret the effects of the magneto-electric field on biostructure as merely the result of electrical induction and conduction, without considering the possible effects of a magnetic force. Such an effect was ruled out, because it was said that since biological tissue did not have large amounts of ferrous material, a magnetic field could not have any effect upon them.

For this reason, the author researched the differences between the abiotic and the biotic (Table 2). Based on this classification, he identified a molecular reference model which clarified the conceptualization of micro-mechanical effects.

Consider two ions, one diamagnetic (with a weak negative magnetic susceptibility) and the other paramagnetic (with a small positive magnetic susceptibility), moving about freely in space each looking for its homologue, joining each other for an instant and forming a molecule, and then separating to once again go on searching for a homologue. In nature, these ions move freely in temperature-related Brownian motion, and it is precisely these motions which regulate exchanges.

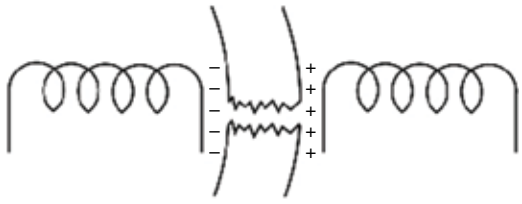


Figure 2
APPLICATION OF THE BASSETT SIGNAL
In Bassett's experiments in the 1970s, oppositely wound solenoids are used to induce a current with an average value greater than zero in the region in question. The passage of current through the fracture zone resulted in the deposit of Ca^{++} ions in the region near the negative pole.

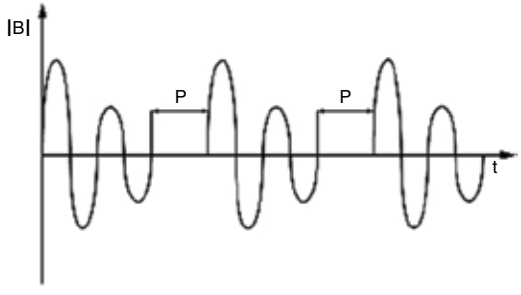


Figure 3
THE WARNKE SIGNAL
Warnke's experiments in the 1970s used sinusoidal signals, punctuated by pauses, to stimulate the metabolic-nutritional aspects of cell function. In his design, charges accumulated on both sides of the membrane.

The Brandimarte model (Figure 4) seeks to demonstrate that the presence of an external magnetic field increases the probability of an encounter between these ions, and hence acts as a physical catalyst. When a magnetic field is applied to diamagnetic or paramagnetic ions, the pre-existing field is deformed, and they are constrained to follow a trajectory coherent with

Table 2
RESPONSE OF ABIOTIC AND BIOLOGICAL SUBSTANCES TO A MAGNETIC FIELD

(μ = magnetic permeability)

Abiotic substances	Biological substances
(1) Ferromagnetic 200 <μ<400	(1) Weak paramagnetic 1 <μ< 10
(2) Paramagnetic 1 <μ<20	(2) Amorphous μ = 1
(3) Diamagnetic –1 <μ< –20	(3) Weak diamagnetic –1 <μ< –10

This classification has served as the basic premise for Brandimarte's studies of magneto-therapy.

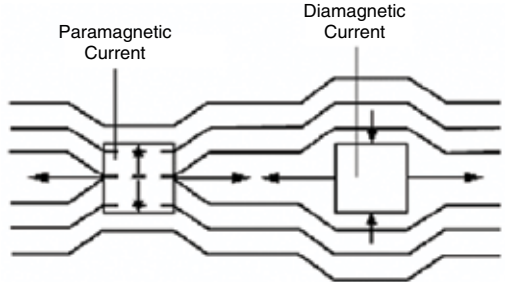


Figure 4
BRANDIMARTE'S MODEL OF FIELD EFFECTS
Motion in the direction which is coherent with the magnetic field is favored, while motion on the perpendicular axis tends to be slowed down.

the direction of the magnetic field.

This model, which takes the molecular level as its reference, is also valid on the cellular level.

If, in fact, we apply magnetic forces to the motion of molecular ions, there is an elastic change in the cell's shape, and, in particular, we observe a "lengthening" of the cell in the direction of the magnetic field. Such "lengthening" has been demonstrated using an electron scanning microscope (see "Experimental Considerations" below). The considerations introduced there make it clear that the biological effect of a magneto-electric field varies according to the type of signal used, and according to its intensity. (It is not to be forgotten that Lorentz forces need a certain intensity in order to act.)

Bassett's Experiment Using Pulsed, Rectangular Signals

It must be said, however, that within the parameters of form and intensity, the principle of superposition of effects rules. Bassett was the first to confront this principle, in the following experiment: He exposed the two ends of a fracture (*in vivo*) to a pulsed magneto-electric field, with the reasonable expectation that Ca^{++} (calcium $^{2+}$) ions would be deposited on the negative pole, and that nothing would happen at the positive pole, or perhaps erosion might occur there.

During his experiments, Bassett found that in addition to a bone deposit on the side exposed to the negative pole, there was also a bone deposit on the side exposed to the positive pole (Figure 5). At that stage, Bassett was unable to explain the why and wherefore of this second deposit, because Warnke's experiments on stimulating fibroblast reproduction had not yet taken place. In reality, since a rectangular signal (as used by Bassett) can be decomposed into its fundamental components (see section on Fourier analysis), you can see that the harmonic composition, first harmonic, third, and so on, of the said signal, constitutes a sum of the alternating signals as used by Warnke (Figure 6).

In practice, by the principle of the superposition of effects, Ca^{++} ions will be deposited as determined by the induced Bassett macro-current, which is strictly dependent upon the orientation of the plane solenoids, and by their position as seen by X-ray.

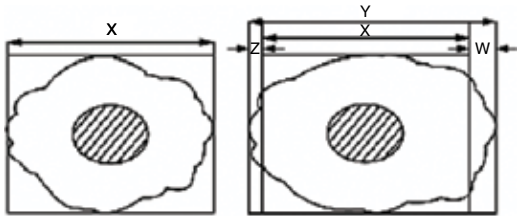


Figure 5
GROWTH OF BONE FRAGMENT AFTER EXPOSURE TO MAGNETO-ELECTRIC FIELD
Measurements are shown for the cross-section of a bone fragment in one of Bassett's experiments. X = the dimensions of the bone fragment before exposure to the magneto-electric field. Y = the dimensions after exposure to the magneto-electric field. Z = the quantity of bone accrued across from the positive pole. W = the quantity of bone accrued across from the negative pole. Bassett could not explain why bone was deposited on both poles.

Physical Principles of Magneto-Therapy

A conductor with an electric current running through it, generates a magnetic field in the space around it. The term magnetic field is a theoretical one. When we speak of a magnetic field that is present within a physical entity, be it in air or in biological tissue, we are referring to magnetic induction, whose strength is denoted by the letter *B* rather than by *H,* which is the

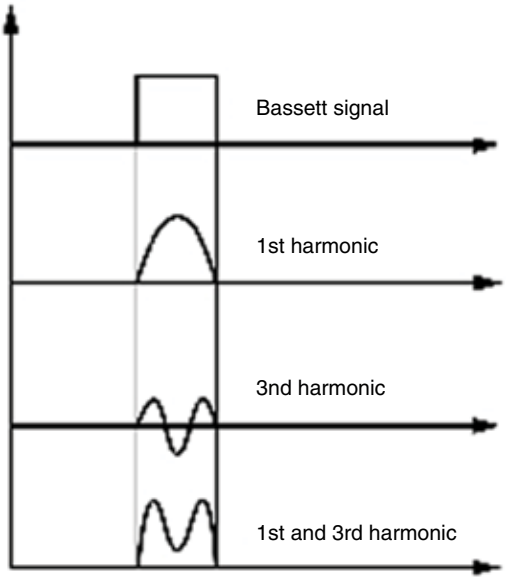


Figure 6
ANALYSIS OF A BASSETT SIGNAL IN A FOURIER SERIES
Brandimarte accounts for the deposition of bone at both poles by showing that Bassett's square wave signal, when broken down into its harmonics, consists of the sum of the alternating signals used by Warnke (Figure 3).

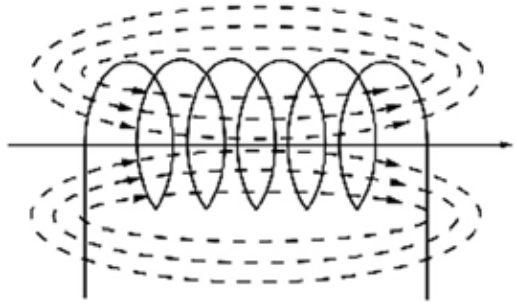


Figure 7 (a)
BELOW 10,000 Hz, THE MAGNETO-ELECTRIC FIELD CONSISTS OF CLOSED LINES OF FORCE
The current enters one end of the coil or solenoid and exits the other, creating an elongated magnetic field. Below a frequency of 10,000 Hz, the field is nonpropagating. It is a mistake to speak of Maxwellian waves and wavelength at this low frequency.

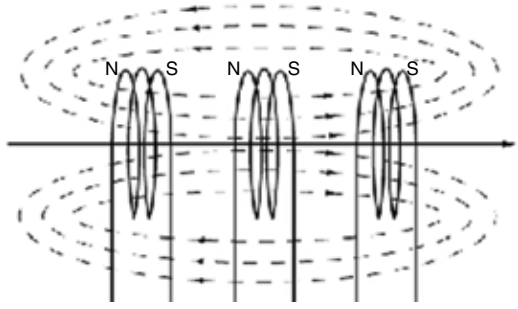


Figure 7 (b)
SCHEMATIC OF MAGNETIC FIELD IN THE ALL BODY® METHOD
The All Body® method typically used three solenoids, with the north and south poles placed end-to-end to form a single emitter in which the patient is immersed.

symbol commonly used to refer to the intensity of a magnetic field.

B is therefore a value which takes into account the medium within which the magnetic field is developed, i.e., it is a real value. If the conductor is wound into a spiral (a coil or solenoid), and if the current is conceived of as entering at one end and exiting at the other, the system of forces generated will no longer be circular, but elongated. The longer the spiral, the more elongated the shape of the magnetic field (Figure 7a).

The north and south poles are located at the ends of the solenoid, their polarity reversing when the current is reversed. If such reversals, rather than occurring only a few times per second, occur many times per second, the lines of force broaden and begin to occupy a much greater space. When the reversal frequency reaches 10,000 Hz, the lines are so spread out that they break up, energy is projected outward, and we can no longer call it a magneto-electric signal, but rather an electromagnetic signal. On this basis, we have made the following classification, where *F* is the frequency of the applied signal:

Magnetic field $F = 0$ Permanent magnet

Magneto-electric field $0 < F < 10{,}000$ Magneto-therapy

Electromagnetic field $F > 10{,}000$ Electromagnetic waves.

In electromagnetic waves, energy is propagated through space (a self-regenerating wave); that is, the field is projected, and the wave begins to travel at the velocity of light, out towards the infinite. However, it is a mistake to talk about wavelength when discussing a magneto-electric field, because the field is closed, and does not travel through space; hence the concept of velocity does not apply. It is a typical error to continue to talk about wavelength at frequencies below 10,000 Hz.

Magneto-therapy utilizes a magneto-electric field, and thus works with closed lines which pass through biological tissue without weakening (giving up energy), in fact often becoming stronger. The principle which makes magneto-therapy work is the presence of the field itself; and the only purpose of the magnetic forces is to orient the magnetic dipoles, which do not require any further consumption of energy once they are oriented, except for the energy necessary to maintain the field and the associated orientation of the dipoles. In many clinical applications, it is necessary to be specific about the area where the magnetic-electric field is to be applied, such as for example with dental or ocular implants; or alternatively, the field is applied to the whole body of the patient where the pathologies are systemic, for example, immuno-deficiency, diffuse osteoporosis, etc.

In the first case, we use solenoids consisting of flat-wound coils utilizing the outside of the emitter and the fact that the intensity of induction decreases rapidly. In the second case, such as in the All-Body® method, more than one cylindrical solenoid (typically three) is used, and the north and south poles are so arrayed that they essentially form a single emitter in which the patient is immersed. In such a case, the intensity is very low and the field is induced over a large volume (Figure 7b).

Different types of naturally occurring substances, both abiotic and biological, respond differently to magnetic fields (Table 2, p. 23).

The classification in Table 2 has served as the basic premise for our studies of magneto-therapy. Until the 1970s, it was thought that the magnetic permeability (μ) of biological tissues was so low that a magneto-electric field would have no effect. However, we discovered that biological materials do respond to a magneto-electric field, and we were able to classify biological materials as distinguished from one another depending on their sensitivity to a magnetic field at the molecular level, as described below.

Magneto-Electric Field Effects on Biological Tissue

1. Phase changes. In general, a phase change is accompanied by the phenomenon of opalescence: Bring a mixture near a magnetic field, and you will observe that it tends to become translucent. Another example: A mixture is brought near a magnetic field and begins to precipitate. Another phase change can be represented by a change in the orientation of the molecules,

such as happens with some gels or ointments.

The proof that orientation is at issue here, is shown by the fact that often the active ingredients of pharmaceuticals are macromolecules whose minor and major axes are in a ratio of 1:600, or even 1:1,000. Since the substances containing the active ingredients have to pass through the cutaneous barrier which consists of dead and flat cells (arranged like the tiles in a tiled roof), it can be useful to orient the molecules in such a way as to increase the probability of their passing through the barrier. Obviously, the dimensions of one of the axes must be comparable to those of the spaces existing in the barrier.

Applying a gel increases this probability, and thus should be used in clinical practice before treatment with a magneto-electric field.

2. Lorentz forces. Lorentz forces are forces between electrical charges. Repulsive Lorentz forces can be brought into play between moving charges of the same sign inside a magnetic field. This is the principle, for example, underlying the magnetic suspension of a maglev train, where the friction is sharply reduced by the magnetic field. We can transpose this example into medicine, to the red blood cells and the capillaries. The red blood cell reaches the cells by passing through progressively smaller blood vessels, whose extremities are smaller than the red blood cell itself.

Keep in mind that blood vessel cells are elastic and create a conduit approximately 6-7 µm in diameter, while the red blood cell has a diameter of around 7-8 µm. That means that the motion of the red blood cells passing through the blood vessels to reach the cells is regulated by friction.

There are essentially three ways to increase blood flow:

(a) Increase the temperature. This can influence the flow in the large blood vessels (vasodilation), but it does not have much influence over the micro-circulation in the small vessels.

(b) Increase the oxygen demand of the cells, which results in the opening of the stomata. This principle is demonstrated, for example, by the laser.

(c) Use magnetic fields strong enough to cause the Lorentz forces to predominate, thus reducing friction in the micro-vessels and temporarily increasing blood flow.

The aforesaid three principles govern hyperemia (the increase of blood flow in the body—not to be confused with micro-angiogenesis), by acting on the velocity and quantity of blood flow.

3. Macro and micro effects of induction. The effects of electrical induction relative to a magnetic field were first studied in the 1970s. (See referenced works by Bassett and Warnke, who studied, respectively, the macro- and the micro-effects of electrical induction.) If a magnetic field, no matter how generated, is made to vary over time by electro-mechanical means, it will induce (generate) a current in an electrical conductor immersed in this variable flux, but the induced current will produce its effect in the direction opposed to that of the electrical or mechanical motion which generated it.

This law, well known to electrical engineers, but often ignored by biologists, turns out to be of fundamental importance, given that man is paramagnetic, because he is made up of water and salts. In 1960, French physicians experimented with a technique for solving bone healing problems, by inserting needles into the extremities of a fractured bone, and connecting these two needles (entirely insulated except for the point) to battery poles. The passage of current through the fracture zone resulted in the deposit of Ca^{++} ions in the region adjacent to the needle connected to the negative pole.

The function of the opposite polarities was to re-establish continuity between the two pieces of the fracture, thus re-establishing normal piezoelectricity between them. This technique, although slow and taxing, produced definite and calculable results, as the laws of electrolysis of Ca^{++} are well known.

Whatever type of signal is applied, the effect will always exhibit an alternating pattern, proportional to the percentage of the sinusoidal signal that is masked within it. The C100 effect is the only magneto-electric field that cannot be traced back directly by Fourier analysis. Being polarized, the C100 field superimposes upon the Fourier-analyzed wave an effect which is exquisitely linked to polarization—i.e., micro-angiogenesis, which is typical only of the C100 signal.

Experimental Considerations

Numerous authors have studied the effects of magnetic fields on various models of biological structures. The results obtained are various and discordant, depending strictly on the form of the wave, the intensity of the field, and the frequencies used. But other parameters, no less important, also seem to come in to play, such as the duration of the exposure to the field and the time chosen to begin applying the field to the selected experimental model. The results of exposing cells, cultivated *in vitro,* to various types of fields, can be quite diverse. Specifically, the work of R. Dixey (1982) demonstrated that pheochromocytoma (adrenal tumor) cells exposed to pulsating magnetic fields exhibited an increased secretion of noradrenalin. R.A. Luben et al. (1982) found that the exposure of osteoblasts cultivated *in vitro* to a magnetic field, blocks the parathyroid hormone's inhibiting action on the synthesis of collagen, while application of the field to the cells themselves does not block the effects of vitamin D3 on collagen synthesis.

Studies by Marinozzi et al. have shown that a continuous double wave is particularly effective in changing the morphology of the cell membrane of Hep 2 type of human skin cancer, and that the alternating sinusoidal wave is capable of increasing proliferative activity and decreasing synthetic activity in fibroblasts isolated from the bone and cultivated *in vitro*.

Studies by P. Conti et al., on human lymphocytes cultivated *in vitro,* would seem to indicate that the stimulating effect of some mitogens, which are chemicals, usually proteins, that encourage mitosis in the cell—ConA (concanavalin A), PHA (phytohaemagglutinin), PWM (pokeweed mitogen)—is strongly inhibited by exposure of the samples to a magnetic field with a square wave. There is a strict correlation between the frequencies used (1-200 Hz, 20-60 gauss), the duration of the exposure, the time when the application of the field to the sample was begun (72 hours, first 12 hours, last 48 hours, and last 6 hours), and the results obtained.

Note, however, that Conti et al.'s experimental conditions did not accurately reflect clinical reality. The best results with such cell samples can be obtained by using consecutive cycles of

Table 3
RESULTS USING ^{3}H THYMIDINE IN HUMAN LYMPHOCYTES

Experiment 1 incorporates ^{3}H Thymidine in lymphocytes stimulated and exposed to magnetic fields (cpm ± DS x 10)

Mitogen	No Field	Field
—	6.02 ± 0.75	17.3 ± 1.6
PHM	101.1 ± 6.1	192.8 ± 13.4
PWM	40.4 ± 8.8	131.5 ± 13.3
ConA	65.2 ± 6.0	145.4 ± 11.2

Experiment 2 incorporates ^{3}H Thymidine in lymphocytes stimulated and exposed to magnetic fields (cpm ± DS x 10)

Mitogen	No Field	Field
—	7.1 ± 1.3	20.3 ± 2.4
PHM	110.8 ± 11.7	204.1 ± 7.4
PWM	47.3 ± 6.4	145.3 ± 4.5
ConA	71.7 ± 8.6	153.9 ± 8.8

therapy, with an alternating sinusoidal wave, at frequencies between 50-100 Hz and 70 gauss, without overly long exposure times. These clinical results led us to study the blastogenesis of human lymphocytes exposed to an alternating sinusoidal magnetic field of 70 gauss, and 100 Hz for 1 hour/day for a number of consecutive days, trying to duplicate as closely as possible the conditions under which magnetic fields are applied in everyday medical practice.

Materials and Methods

Our investigations used human lymphocytes taken from heparinized venous blood from healthy young donors and isolated using the Ficoll-Hypaque density gradient. The cells collected were subjected to three washings in the RPMI 1640 medium, with added 2nM glutamine, FCS at 10 percent and antibiotic-antimycotics at 1 percent. The lymphocytes thus obtained were placed in micro-wells (Falcon) at a concentration of 2×10^5 cells in 0.2 ml of medium, and incubated in a humid environment, at 37°C, in the presence of CO_2 at 5 percent, with and without the addition of mitogens (PHA Difco at a concentration of 20µg/ml; with concavalin A Calbiochem at a concentration of 5 µg/ml; PWM Calbiochem diluted 1:256 with the stock solution).

Each experiment was done in quintuplicate, and the plates thus obtained were subdivided into two groups, one of which was a control, and the other was subjected to an alternating sinusoidal field, 70 gauss, 100 Hz, 1 hour per day for three consecutive days of incubation. On the fourth day, ^{3}H Thymidine was added at a concentration of 3 µCi/ml to the plate of both groups, and then after another six hours of incubation the samples were scarified (that is, slit with shallow cuts) and the radioactivity was measured with a beta counter.

Results Obtained

Table 3 shows the results of incorporating ^{3}H Thymidine in human lymphocytes, both normal lymphocytes and lymphocytes stimulated by various lectins (PHA,Con-A, PWM), when exposed to a sinusoidal alternating magnetic field for 1 hour per day for three consecutive days, compared to the figures for lymphocytes, incubated and stimulated the same way, but not subjected to any kind of field. The results show that the exposure of the lymphocytes to the field has a stimulating effect on their blastogenesis, as can be seen from the values of the samples where no lectins were added.

It is shown that the reactions of samples treated with various mitogenic agents and exposed to the field, vary depending upon the mitogen used.

In fact, the lymphocytes that were stimulated most in an absolute sense, were those which were put into the culture with the PHA, perhaps because the lectin seems to act on both of the

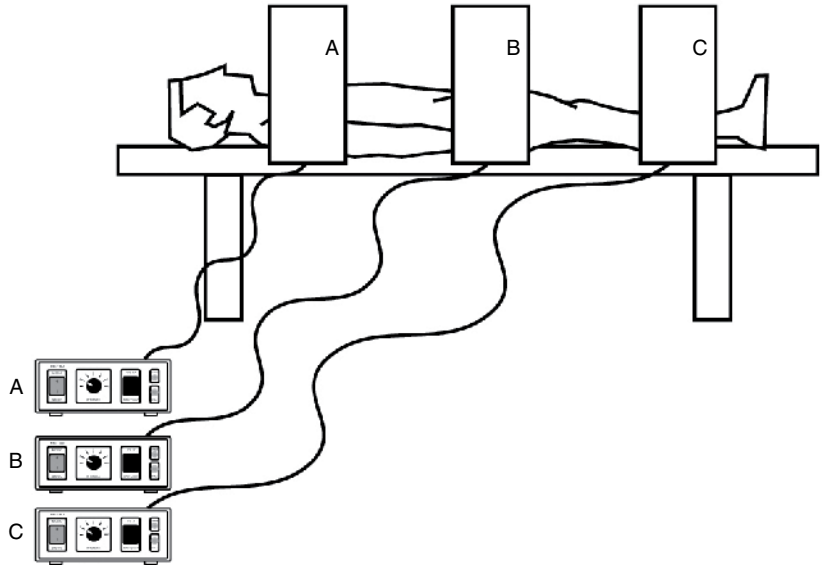


Figure 8
PLACEMENT OF THE SOLENOIDS IN THE ALL BODY® METHOD
The schematic shows the positioning of the solenoids on the plane of the bed and also relative to the patient. If the patient is being treated for problems affecting the entire body, all three generators are turned on; otherwise, one generator at a time is turned on depending upon the parameters reported.

Figure 9
RESULTS FOR TREATMENT OF DIABETIC VASCULOPATHY
The photos show the progressive healing of diabetic wounds treated with the magneto-therapy protocol, from June 28, 1984 (a), to August 30, 1984 (b), to May 2, 1985 (c). The patient was treated by Dr. Mauro Martinelli at the S. Pietro di Roma Hospital.

lymphocyte populations (B and T).

On the other hand, the samples stimulated with PWM show a greater increase of blastogenesis as a percentage, while the stimulating effect of the Con-A's is intermediate between the other two lectins.

All Body® Magneto-Therapy for the Immunosuppressed

First, we look at the general case of immunosuppression resulting from AIDS treated with chemotherapy. (The All-Body® configuration is shown in Figure 8.)

In current practice, after a patient has been tested and confirmed to be seropositive for the HIV retrovirus between two months and one year after the suspected contagion, the patient is given pharmaceutical cocktails such as AZT or others less toxic. In many cases, the choice of active principles is determined by the reaction of the patient. The purpose of administering such drugs is to slow down as much as possible the transition from the simply seropositive phase to full-blown AIDS. In a patient who already has "full-blown AIDS," the purpose of the treatment is to increase the survival period and to improve the quality of life.

In both phases the ultimate object is to stabilize the illness, causing it to return to the latent stage.

Along with the primary treatment, all available treatments are used in order to maximally limit opportunistic infections, which are often the actual cause of death.

In the case of cancer, after surgery and/or during chemotherapy, there is a significant reduction in the immune defense system of cancer patients.

It is therefore completely coherent with the general method

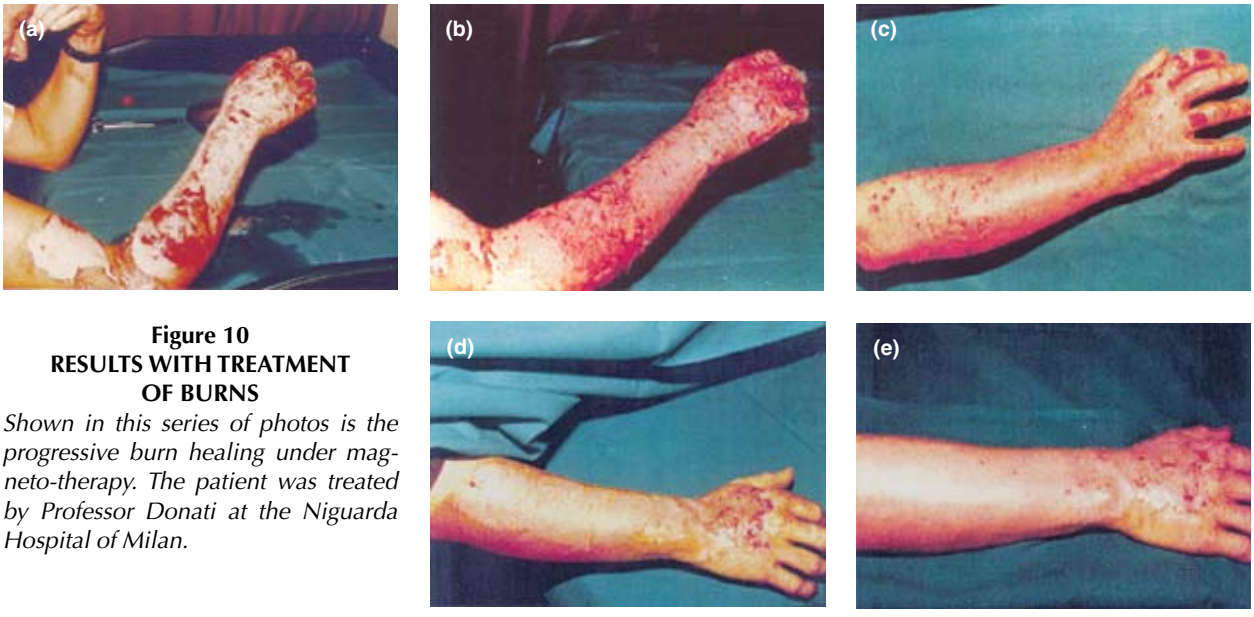
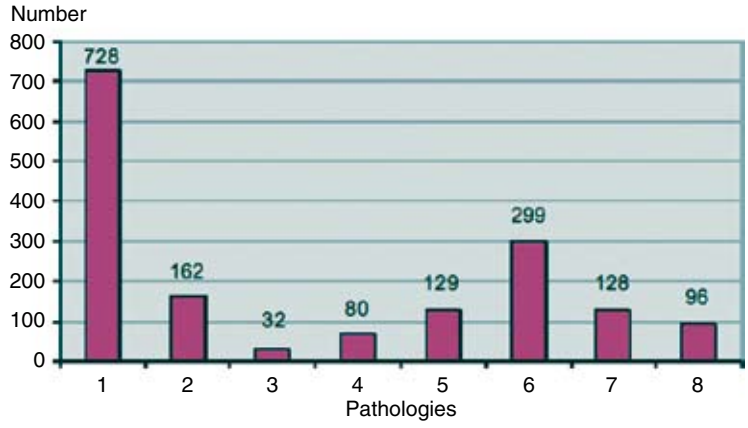


Figure 10
RESULTS WITH TREATMENT OF BURNS
Shown in this series of photos is the progressive burn healing under magneto-therapy. The patient was treated by Professor Donati at the Niguarda Hospital of Milan.

Figure 11
NUMBER OF CASES TREATED (2000-2009)



The total number of cases treated with magneto-therapy for eight different pathologies. The results for each pathology are shown in Figure 12.

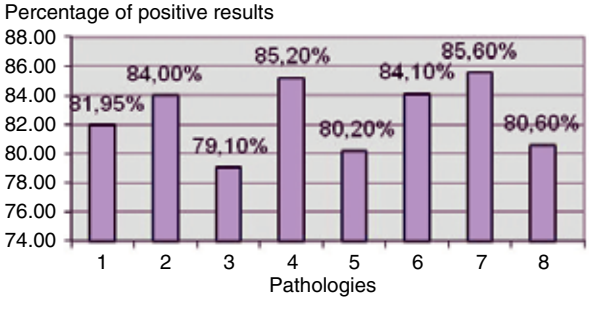
outlined above and the principles researched in recent years, to recommend supporting pharmacological therapy with various types of magneto-electric fields (Marinozzi et al.). This would include the use of the All-Body® apparatus, specifically studied and tested, including for home use, for treating the whole patient with specific, low frequency magneto-electric fields (see tables). The fields are low intensity and practically without contraindications for even debilitated patients.

Furthermore, it has been scientifically demonstrated that magnetic fields can increase the rate of reproduction of human lymphocytes, one of the primary components of the phagocyte flora which defend the organism against infections (Marinozzi et al. DATE).

The effect of specific magneto-electric fields on the rate of cellular reproduction (fibroblasts) and on the general tone of the organism afflicted with inflammatory illnesses, can be sedating or stimulating depending on the type of signal applied.

It is evident that magneto-electric fields have significant effects on opportunistic illnesses, when combined with standard treatment of the primary syndrome, as well as such co-adjuvant effects as increasing the effect of basic therapeutic drugs, strengthening the immune defenses, increasing the latency time, improving toleration to drugs, and survival time,

Figure 12
PERCENTAGE OF POSITIVE RESULTS
(2000/2002-2009)



Shown are the percentage of positive results when checked 7 to 9 years later, for persons treated with magneto-therapy from 2000-2002 to 2009, for eight different pathologies identified in the text.

Hundreds of Patients

Successful application of magneto-therapy to support traditional treatment with hundreds of patients convinced us to continue such treatments methodically, in pursuit of objectives such as increasing the immune defenses, eliminating drugs remaining in the body from previous treatments, facilitating the transport of chemotherapeutic drugs across cell membranes, increasing the efficacy of chemotherapy (especially useful in the treatment of cerebral pathologies), and improving tolerance to chemotherapy treatment.

More than three years ago, a service was started at S. Camillo di Roma Pad. Marchiafava Hospital, initially run by Dr. Paola Dionette, and later by Dr. Daniella Ingletto, to treat all the afflictions requiring the All Body® apparatus. The program was run in coordination with the IATREIA S.r.l., which provided the specific apparatus and technical-scientific consultation.

Numerous patients were treated at home, in coordination with Prof. Francesco Silvestri from Modena, who gives master classes at the University of Aquila on "Physical Methods Combined with Drug Therapy."

The magneto-electric fields generated by the All Body® apparatus can be applied to many rheumatological and other illnesses requiring physical rehabilitation, as well as to pain therapy for patients with metastasized cancer, or to pathologies affecting a large portion of the body, such as diffuse osteoporosis. We have selected results obtained with groups of patients on whom All Body® low-frequency, low-intensity magneto-electric therapy was used as the primary coadjuvant.

The principal groups were patients

(1) recovering from cancer surgery, including those being treated with chemotherapy and radiotherapy

(2) with hepatitis and hepatopathologies

(3) who were seropositive, some of them with full-blown AIDS

(4) with rheumatoid arthritis

(5) with fibroids

(6) with generalized osteoporosis

(7) with autoimmune diseases

(8) with diabetes

Some of our results can be seen in Figures 9-12, and more details are available in the papers cited below.

Based on these successes, we recommend magneto-therapy as a primary co-adjuvant in association with standard pharmacological therapies.

References

Dr. Rosario Amelio, 2004/2005. "Trattamento con mezzi fisici (LLLT e CMELF) di stravasi e/o flebiti chimiche (da farmaci antiblastici e non) e da cause meccaniche." Universitá Degli Studi l'Aquila. Master annuale di II livello a.a. 2004/2005 in *I Mezzi Fisici in Coordinamento con la Farmacologia.*

C.A.L. Bassett, 1982. *Calcif. Tiss. Int.,* Vol. 34, No. 1.

_____, 1982. *J. Bone and Joint Surg.,* Vol. 64, No. 6, pp. 888-95.

A, Boyum, 1968. *Scand. J. Clin. Lab. Invest.,* Vol. 21, pp. 31-50.

P. Conti et al., 1983. *FEBS Letters,* Vol. 162, No.1, pp. 156-60 (Oct.).

R. Dixey and G. Rein, 1982. *Nature,* Vol. 296, pp. 253-56.

S. Jackson and C.A.L. Bassett, 1980. In *Tissue Culture in Medical Research (II)*, eds. R.J. Richards and K.T. Rajan (Oxford: Pergamon Press), p. 21.

OBA. Laffranchi, V. Fossati, F. Bianchi, M. Galassi, L. Ascani, F. de Conno, S. Serrano, 2008. "Recupero di lesioni croniche nel malato oncologico," Istituto Nazionale per lo Studio e la Cura dei Tumori di Milano, Università di Milano. (Presentation at the XVII National Confrence of the Interdisciplinary Neurovascular Assocation, Dec. 11-13.)

A. Laffranchi, F. Ferrari, L. Ascani, L. Craba, P. Campanini, B. Cotza, P. Placucci, S. Serrano. "Le 'USTIONI' da Raggi X Trattamento dell'eritema bolloso," Istituto Nazionale per lo Studio e la Cura dei Tumori di Milano. (From case histories between May 1999 and Oct. 2002.)

A. Laffranchi, G. Secreto, S. Serrano, 2003. "Prevenzione e terapia delle lesioni acute e croniche da raggi," Istituto Nazionale per lo Studio e la Cura dei Tumori di Milano. In *La Medicina Biological,* Jan.-March.

R.A. Luben, D.C. Cain, M. Chi-Yun Chen, D.M. Rosen, D.M., W.R. Adey, 1982. *Proc. Natl. Acad. Sci.,* Vol. 79, pp. 4180-84.

G. Marinozzi, et al., 1982. *Giorn. It. Oncol.*, Vol. 2, No. 87.

G. Marinozzi, et al., 1984. "40° *Conv. Naz. Soc. It. Anatomia," Milan,* Ricerca Scientifica ed. *Educazione Permanente.* Supp. 38.

G. Marinozzi, B. Brandimarte et al., 1993. "Inquadramento generale dell'interazione fra i Campi Magnetici e materia Vivente" (General Framework for the Interaction between Magnetic Fields and Living Matter) in *Magnetic Fields in Medicine,* 2nd Edition, Chapter 5, Ed. Franco Bistolfi (in Italian).

G. Marinozzi, B. Brandimarte et al., 1993. "Effects on cell cultures of sinusoidal ELF magnetic fields" in *I Campi Magnetici in Medicina* (Magnetic Fields in Medicine), 2nd Edition, Chapter 26, Ed. Franco Bistolfi (in Italian).

G. Marinozzi, B. Brandimarte et al., 1993. "Effects of magnetic fields on in vitro human lymphocyte cultures." in *Magnetic Fields in Medicine,* 2nd Edition, Chapter 26, Part 2a, Ed. Franco Bistolfi (in Italian).

P. Massidda and B. Brandimarte, 2003. *Principi e fondamenti di Magnetoterapia e Laserterapia,* Ed. Iatreia (in Italian).

T.S. Tenford, ed., 1979. *Magnetic Field Effects on Biological Systems* (New York: Plenum).

U. Warnke U., 1978. "Aspects of the Magnetic Force Effect on Biological Systems," *Die Heilkunst,* Vol. 91, pp. 1-12.

Observations on Chernobyl After 25 Years of Radiophobia

by Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

Vadim Mouchkin/IAEA

Aerial view of the Chernobyl nuclear power plant encased in its sarcophagus.

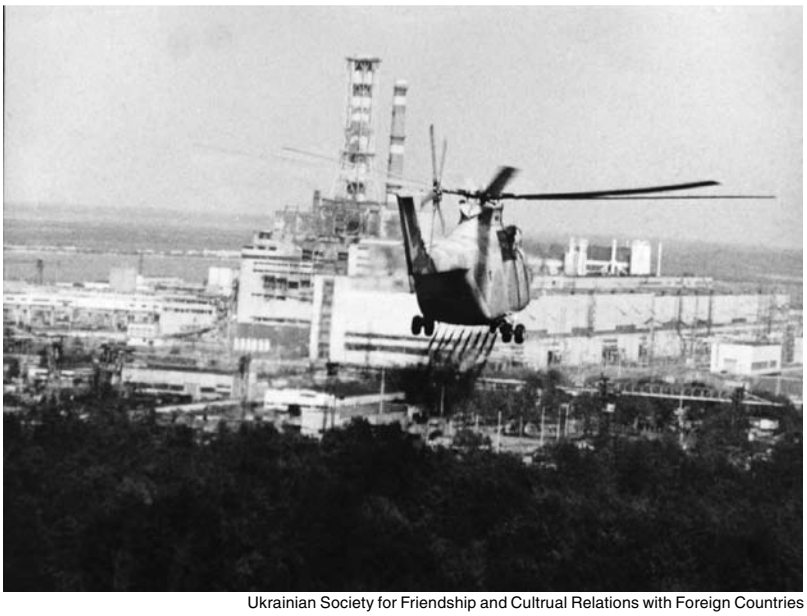
Ten days after two steam and hydrogen explosions blew up the Chernobyl nuclear reactor, the fire that melted its core died out spontaneously. But the drama of this catastrophe still flourishes, nourished by politics, authorities, media, and interest groups of ecologists, charitable organizations, and scientists. It lives in the collective memory of the world and propagates real health, social, and economic harm to millions of people in Belarus, Russia, and the Ukraine. It is exploited in attempts to strangle the development of atomic energy, the cleanest, safest, and practically inexhaustible means to meet the world's energy needs. The world's uranium resources alone will suffice for the next 470,000 years (IAEA 2008).

Chernobyl was indeed an historic event; it is the only nuclear power station disaster that ever resulted in an occupational death toll, albeit a comparatively small one. A vast environmental dispersion of radioactivity occurred that did not cause any scientifically confirmed fatalities in the general population. The worst harm to the population was caused not by radiation, and not to flesh, but to minds.

The worst possible nuclear plant accident produced no scientifically confirmed fatalities in the general population. But there was enormous political and psychological damage, mainly the result of belief in the lie that any amount of radiation is bad.

This catastrophe provided many invaluable lessons. One of them is a recognition of the absurdity of the prevailing linear no-threshold hypothesis (LNT), which assumes that even near-zero radiation dosage can lead to cancer death and hereditary disorders. That the LNT is false, is shown by observing that such damage did not occur after Chernobyl.

Chernobyl was the worst possible catastrophe. It happened in a dangerously constructed nuclear power reactor with a total meltdown of the core and 10 days of free emission of radionuclides into the atmosphere. Probably



Ukrainian Society for Friendship and Cultrual Relations with Foreign Countries

A helicopter at the Chernobyl site in 1986, checking the damage to the reactor.

nothing worse could happen. Yet, the resulting human losses, although tragic, were minute in comparison with catastrophes from other energy sources.

Highly sensitive monitoring systems that had been developed in many countries for the detection of fallout from nuclear weapons enabled easy detection of minute amounts of Chernobyl dust, even in remote corners of the world. This added to global epidemics of fear induced by the accident.

Radioactive debris was dispersed into the troposphere and stratosphere of the Northern Hemisphere. up to at least 15 km altitude (Jaworowski and Kownacka 1994). On the first few days after the accident, the concentrations of radiocesium measured at this altitude over Poland (maximum 36.1 mBq/cubic meter at standard temperature and pressure, or STP) was 2 to 6 percent of that at the ground level. Such a high vertical distribution and mixing enabled a small portion of Chernobyl debris to pass over the equatorial convergence and into the Southern Hemisphere (Philippot 1990), and on to the South Pole (Dibb et al. 1990, Philippot 1990). This was not in agreement with computer-generated models of nuclear accidents, which projected a maximum uplift of fission products to below 3,000 meters altitude (ApSimon et al. 1985, ApSimon and Wilson 1987).

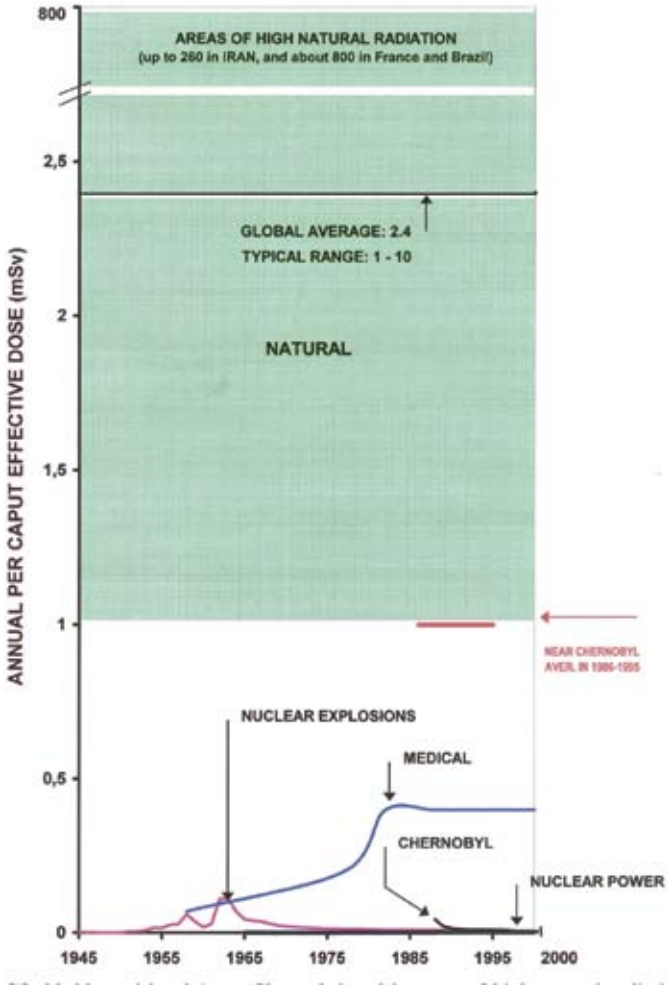


Figure 1
WORLDWIDE RADIATION DOSES COMPARED WITH CHERNOBYL

Average annual radiation doses from natural and man-made sources, worldwide, near Chernobyl, and in areas of high natural radiation. The radiation from Chernobyl is dwarfed in comparison with natural backgound radiation.

Source: Based on UNSCEAR (1988, 1993, 1998, 2000b)

Enormous amounts of radionuclides entered the air from the burning reactor. Yet the total emission was 200 times less than from all of the 543 nuclear warheads exploded in the atmosphere since 1945. The highest estimated radiation dose exposure to the average member of the world population was 0.113 mSv, recorded in 1963 (UNSCEAR 1988). The radiation doses from Chernobyl dust were estimated and compared with natural doses by UNSCEAR (2000a). During the first year after the accident, the average dose received by an average inhabitant of the Northern Hemisphere was estimated by UNSCEAR as 0.045 mSv, that is, less than 2 percent of the average global annual natural dose (2.4 mSv per year).

During the next 70 years, the global population will be exposed to a total Chernobyl dose

of approximately 0.14 mSv, or 0.08 percent of the natural lifetime dose of 170 mSv. People living in the most contaminated areas of the former Soviet Union received an average individual annual whole-body radiation dose in 1986-1995 of 0.9 mSv in Belarus, 0.76 mSv in Russia, and 1.4 mSv in Ukraine (UNSCEAR 2000b). Average doses estimated for the period 1986-2005 are 2.4 mSv in Belarus, 1.1 mSv in Russia, and 1.2 mSv in Ukraine (UNSCEAR 2008), respectively.

All these doses are dwarfed in comparison with natural radiation doses in some parts of the world. For example, in Ramsar, Iran, natural radiation doses reach more than 400 mSv/year (Mortazawi et al. 2006), and in Brazil and southwestern France, natural radiation doses reach up to more than 700 mSv per year (UNSCEAR 2000b). (See Figure 1.)

A comparison of these doses and epidemiological observations should be a basis of realistic estimates of the latent medical consequences of the Chernobyl accident, rather than risk factors based on the LNT. Such a comparison, and the comparatively minute health consequences, were apparent soon after the catastrophe (Jaworowski 1988), but this information was not shared with the public. Recently the well-known British environmentalist James Lovelock, best known for his Gaia theory, dispelled at length all the usual myths that surround the Chernobyl accident. Lovelock stated that for many years the scientists who could have challenged the nonsense about the catastrophe chose to keep quiet (Murphy 2009). I do not feel guilty.

No harmful health effects have ever been detected in high natural background radiation areas. This is consistent with other studies of the incidence of cancers in exposed populations. In the United States and in China, for example, the incidence of cancers was found to be lower in regions with high natural radiation than in regions with low natural radiation (Frigerio et al. 1973, Frigerio and Stowe 1976, Wei 1990). Among British radiologists exposed mainly to X-rays, cancer mortality was found to be lower by about 50 percent than that in the average male population of England and Wales (Berrington et al. 2001).

Also, in other population groups exposed to low doses of ionizing radiation (i.e., patients diagnosed with iodine-131 and X-rays, dial painters, chemists, and others exposed to ingested or inhaled radium or plutonium, persons exposed to higher levels of indoor radon, and A-bomb survivors) a lower percentage of neoplastic malignancies was observed (Cohen 2000, Luckey 2003, UNSCEAR 1994). A Taiwan study of several thousand residents of apartments contaminated with cobalt-60, who had been chronically exposed to gamma rays for up to 20 years, with total doses estimated to range from 120 to 4,000 mSv, revealed that the cancer mortality and congenital malformations of these residents substantially decreased rather than increased (Chen et al. 2004), suggesting a stimulating or hormetic effect of low doses of low linear-energy-transfer (LET) ionizing radiation.

This finding was partially confirmed by a later study on cancer incidence in a similar Taiwan cohort, in which for all cancers (except leukemia and solid cancers), with the number of cancer cases ranging from 119 to 190, there was a deficit of incidence found in comparison with the unexposed population. In groups of all types of leukemia and of some solid cancers of particular organs, the number of cases was 1 to 2 orders of magnitude smaller than in the first three groups (Hwang 2008).

Environmentalists for Nuclear Energy

An orange from Ramsar, Iran, the region with one of the highest natural background radiation levels in the world. The Ramsar population has lower cancer rates than those of other areas. No harmful health effects have ever been detected in high natural background radiation areas.

About 3,000 reports on radiation hormesis were recently reviewed (Luckey 2003). In one study, among approximately 200,000 American, British, and Canadian nuclear workers exposed to radiation, the total cancer deaths ranged from 27 percent to 72 percent of the total cancer deaths in the control group of non-nuclear workers (Luckey 2003). Such an hormetic deficit invalidates the LNT, because the concept of hormesis transcends any hypothesized dose threshold for excess cancers. If there were no hormesis, the existence of a true threshold for excess cancers might be impossible to demonstrate rigorously, because of the statistical problems of proving an absolute equality of effect in an epidemiological study at a very low dose level. If, however, a deficit of cancers is observed in the population irradiated at a relatively low dose level, as in hormesis, there is often a statistically significant difference at an acceptable confidence level (Webster 1993). This remark of Webster, an UNSCEAR member, reflects discussions in the Committee during preparation of its report on hormesis (UNSCEAR 1994).

A more recent study, based on collective doses for about 400,000 nuclear workers, found a 31 percent decrease in relative cancer mortality (Cardis et al. 2007), but nevertheless concluded that these cancer death data were consistent with the LNT relationship. This conclusion was based on an *ad hoc* accepted assumption of a confounding "healthy worker" effect for the studied cohort. It was assumed that the nuclear workers were selected for employment because they were more healthy. However, the existence of this effect was not supported by their data or by any other factual evidence.

The "healthy worker" effect could be correctly assumed only if the cancer marker diagnostics (ACS 2009) and genetic tests were used in pre-employment screening and selection of these workers. But these procedures were not applied in the Cardis et al. cohort, and even now they are not recommended by the In-

An imaginary six-foot chicken from Chernobyl, written up as news in the National Enquirer *in 1986. Other products of hysteria about Chernobyl radiation, including doctored photos, are still in circulation.*

ternational Commission on Radiological Protection, the directives of the European Union, or the IAEA International Basic Safety Standards. Thus, this assumption is invalid and explains nothing.

On the other hand, the statistical re-analysis of Cardis et al. data clearly documents that their assumption of a "healthy worker" effect was incorrect, and their data indicated that low doses of ionizing radiation induced a hormetic effect in the exposed nuclear workers (Fornalski and Dobrzynski 2009).

Chernobyl vs. Other Industrial Accidents

In terms of human losses (there were 31 early deaths) the accident in the Chernobyl nuclear power plant was a minor event compared with many other major industrial catastrophes. In the 20th Century, more than 10 such catastrophes have occurred, with tens of thousands of fatalities in each. For example, coal smog killed approximately 12,000 people in London, between December 1952 and February 1953 (Bell and Davis 2001). The annual death toll from accidents in Chinese coal mines reached 70,000 deaths in the 1950s, and 10,000 in the 1990s (WNA 2009). In 1984, about 20,000 people perished after an explosion in a pesticide factory in Bhopal, India (Dhara and Dhara 2002); and the collapse of a hydroelectric dam on the Banqiao river in China in 1975 caused 230,000 fatalities (Altius 2008, McCully 1998, Yi 1998).

The world does not celebrate the anniversaries of these enormous man-made disasters, but year after year we do so for the hundreds and thousands of times less deadly Chernobyl accident. Ten years ago I discussed the possible causes of this paranoiac phenomenon (Jaworowski 1999). Measured as early deaths per electricity units produced by the Chernobyl facility (nine years of operation, total electricity production of 36 gigawatts of electricity (GWe), 31 early deaths) yields 0.86 deaths/GWe-year). This rate is lower than the average fatalities from a majority of other energy sources.

For example, the Chernobyl rate is 9 times lower than the death rate from liquefied gas (Hirschberg et al. 1998) and 47 times lower than from hydroelectric stations (40.19 deaths/GWe-year including the Banqiao disaster). But the political, economic, social, and psychological impact of Chernobyl was enormous. Let's examine what happened starting with my personal experience.

Psychology Tuned by LNT

At about 9 A.M. on Monday, April 28, 1986, at the entrance to my institute in Warsaw, I was greeted by a colleague who said: "Look, at 7:00 we received a telex from a monitoring station in northern Poland saying that the beta radioactivity of the air there is 550,000 times higher than the day before. I found a similar increase in the air filter from the station in our backyard, and the pavement here is highly radioactive."

This was a terrible shock. My first thought was, A NUCLEAR WAR! It is curious that all my attention was concentrated on this enormous rise of total beta activity in the air used to monitor radiation emergencies from nuclear test fallout. Many years spent during the Cold War on preparations to defend the Polish population against the effects of a nuclear attack had conditioned my colleagues and me to have such an exaggerated reaction.

We reacted that way although we knew, that on this first day of Chernobyl in Poland, the dose rate of external gamma radiation penetrating our bodies was higher only by a factor of 3 from the day before, and it was similar to the average natural radiation doses which from time immemorial we have received from ground and cosmic radiation. At 11 A.M., after we had collected enough dust from the air for gamma spectrometry measurements, we discovered that it contained cesium-134. Thus, we knew that its source was not an atomic bomb, but a nuclear reactor. This was tranquilizing news, which did not, however, calm our frantic behavior.

In 1986, the impact of a dramatic increase in atmospheric radioactivity dominated my thinking—and everybody else's. This state of mind led to immediate consequences. First there were various hectic actions, such as *ad hoc* coining of different limits for radionuclides in food, water, and other things. In particular countries, these limits varied by a factor of many thousands, reflecting various political and mercenary factors and the emotional states of the decision makers.

For example, Sweden allowed for 30 times more radioactivity in imported vegetables than in domestic ones, and Israel allowed less radioactivity in food from Eastern Europe than from Western Europe. The cesium-137 concentration limit in vegetables imposed in the Philippines was 22 Bq per kg, 8,600 times lower than in the more pragmatic United Kingdom (Salo and Daglish 1988). In Poland, a group of nuclear physicists and engineers proposed a cesium-137 limit of 27 Bq in 1 kilogram for any kind of food, but, fortunately, the authorities decided more soberly and imposed a 1,000 Bq limit.

Behind these restrictions, meaningless from the point of view of human health, stood three factors: (1) emotion; (2) the LNT mindset and the international recommendations based on it; and (3) a social need to follow an old medical rule, *Ut aliquit fecisse videatur* (to make it appear that something is being done). That third factor was a placebo used by the authorities to dodge the worst kind of criticism, i.e., accusations of inactivity in the face of a monstrous disaster. This led to an overreaction in Europe and in some other countries, but at the greatest scale and with the most severe consequences in the Soviet Union.

The High-Cost of Hysteria

The costs of these regulations were enormous. For example, Norwegian authorities introduced a cesium-137 concentration limit of 6,000 Bq/kg in reindeer meat and game, and a 600 Bq/kg limit for sheep (Henriksen and Saxebol 1988). A Norwegian eats an average of 0.6 kg of reindeer meat per year. The average radiation dose from eating this amount of meat is estimated to be about 0.047 mSv per year. Thus, this measure was aimed to protect Norwegians against a radiation dose about 200 times lower than the natural dose in some regions of Norway of 11 mSv per year (UNSCEAR 1982).

The costs of this protection climbed to over $70 million in 1986, and in the 1990s it was still about $4 million per year (Christensen 1989, Idas and Myhre 1994). This means that unnecessary and wasteful restrictions, once implemented under the influence of the above three factors, have a long lifetime.

The hysterical reaction of authorities, further excited by extremely exaggerated media reports, is well exemplified by the Japanese government's cancellation of a several-hundred-million (in U.S. dollars) contract for shipping Polish barley to Japan for the production of beer. This happened in May 1986, a few days after completely false information of extreme contamination of Poland by Chernobyl fallout appeared on the front page of the biggest Japanese daily, *Asahi Shimbun*. It screamed with block letters, "DUST OF DEATH IN POLAND," and it cited my name as the source of the information.

I was asked by the Polish government to write a text in English which might be used to avert this loss of money. I did this during a weekend spent with my wife in our cottage on the banks of the Vistula, together with John Davis, the American ambassador to Poland, and his charming wife, Helene. When I finished my writing assignment, I asked John to correct the language. He said that the English was almost OK, but not exactly in proper diplomatic style. He then proceeded to change the text completely.

Katarzyna Dopieralska-Skowronska

Author Zbigniew Jaworowski, speaking here at a 2005 geophysical meeting in Warsaw.

On Monday a spokesman for the communist government asked me to read the text at his press conference. I presented the talk, but after I finished, he distributed copies of the talk to the waiting flock of journalists. He was totally unaware that the written text had been prepared by the U.S. ambassador. A visit by the Japanese ambassador to our Central Laboratory for Radiation Protection managed to salvage the contract.

A few days later, Ambassador Davis arranged an international deal for shipment by air of large quantities of powdered milk for Polish children, to replenish strategic reserves that were rapidly being depleted. This was not an easy task, because other European countries, in a similar position to ours, refused to sell their milk. As we now know, during the next four years the Davises played a delicate but pivotal role in realizing a major goal for the people of Poland, the Solidarity movement's victory over communism (Davis 2009, Davis et al. 2006). As explained below, Solidarity's triumph was related to the Chernobyl accident.

The Costly Folly of LNT

A classic example of wastefully applying the LNT principle to the Chernobyl emergency was provided by Swedish radiation-protection authorities. When the farmers near Stockholm discovered that the Chernobyl accident had contaminated their cows' milk with cesium-137, above the limit of 300 Bq per liter imposed by authorities, they wrote the authorities to ask if their milk could be diluted with uncontaminated milk from other regions, to bring it below the limit. This would be done by mixing 1 liter of contaminated milk with 10 liters of clean milk.

To the farmers' surprise and disappointment, the answer was "no," and the milk was then to be discarded. This was a strange ruling since it has always been possible to reduce pollutants to safer levels by dilution. We do this for other pollutants in foodstuffs, and we dilute fumes from fireplaces or ovens with atmospheric air in the same way that nature dilutes volcanic emissions or forest fire fumes. The Swedish authorities explained that even though the individual risk could be reduced by diluting the milk, this would, at the same time, increase the number of consumers. Thus, the risk would remain the same, but now spread over a larger population (Walinder 1995).

Although ridiculous, this was a faithful application of the International Commission on Radiological Protection recommendations, based on the LNT assumption and its offspring, the concept of "collective dose"; that is, reaching terrifyingly large numbers of man-sieverts by multiplying tiny, innocuous individual radiation doses by a large number of exposed people.

Elisabeth Zeiller/IAEA

A local market, where food samples were taken for use in the IAEA diet study of the Chernobyl Assessment Project. The hysteria around the accident and the adherence to the LNT thesis led to widely varying regulations restricting food use that cost European nations millions of dollars.

In an earlier paper, I exposed the negative consequences and lack of sense in the LNT assumption, and the collective dose and dose-commitment concepts (Jaworowski 1999). The application of these principles has caused the costs of the Chernobyl accident to exceed $100 billion in Western Europe (Becker 1996), and much more in post-Soviet countries where it has led to untold suffering and the pauperization of millions of people. The international institutions standing behind this assumption and these concepts certainly will not admit responsibility for their disastrous consequences. They should.

Some LNT History

The linear no-threshold hypothesis was accepted in 1959 by the International Commission on Radiological Protection (ICRP 1959) as the philosophical basis for radiological protection. This decision was based on the first report of the newly established United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1958). A large part of this report was dedicated to a discussion of linearity and of the threshold dose for adverse radiation effects.

Fifty years ago, UNSCEAR's stand on this subject was formed after an in-depth debate that was not without influence from the political atmosphere and issues of the time. The Soviet, Czechoslovakian, and Egyptian delegations to UNSCEAR strongly supported the LNT assumption, and used it as a basis for recommendation of an immediate cessation of nuclear test explosions. The LNT was also supported by the Soviet Union during the later years of the Cold War (Jaworowski 2009), and this was consistent with the thinking of American authorities.

The target theory prevailing in the 1950s and the then new results of genetic experiments with fruit flies irradiated with high doses and dose rates, strongly influenced this debate. In 1958, UNSCEAR stated that contamination of the environment by nuclear explosions increased radiation levels all over the world and thus posed new and unknown hazards for present and future generations. These hazards, UNSCEAR stated, cannot be controlled, and "even the smallest amounts of radiation are liable to cause deleterious genetic, and perhaps also somatic, effects."

This sentence had an enormous impact in subsequent decades, and has been repeated in a plethora of publications. Even today, it is taken as an article of faith by the public. However, throughout the entire 1958 report, the original UNSCEAR view on LNT remained ambivalent. As an example, UNSCEAR accepted as a threshold for leukemia a dose of 4,000 mSv (page 42); but at the same time, the Committee accepted a risk factor for leukemia of 0.52 percent per 1,000 mSv, assuming LNT (page 115). The committee quite openly presented this difficulty, and showed its consequences in a table (page 42).

Continuation of nuclear weapons tests in the atmosphere was estimated to cause 60,000 leukemia cases worldwide, if no threshold were assumed, and zero leukemia cases if a threshold of 4,000 mSv were in place. In its final conclusions, UNSCEAR pinpointed this dilemma: "Linearity has been assumed primarily for purposes of simplicity," and "There may or may not be a threshold dose. The two possibilities of threshold and no-threshold have been retained because of the very great differences they engender."

After a half-century, we still discuss the same problem. In 1958, UNSCEAR had no doubts about major genetic defects in the world population that could be caused by nuclear test fallout, and estimated them as high as 40,000. But later, the Committee learned that even among the children of highly irradiated survivors of atomic bombings, no statistically significant genetic damage could be demonstrated (UNSCEAR 2001).

However, in the International Commission on Radiological Protection document of 1959, no such controversy and no hesitations appeared. The LNT was arbitrarily assumed, and serious epistemological problems related to the impossibility of finding harmful effects at very low levels of radiation were ignored. Over the years, the working assumption of the International Commission in 1959 came to be regarded as a scientifically documented fact by the mass media, public opinion, and even many scientists. The LNT assumption, however, is not a proven scientific principle, and belongs in the realm of administration (Jaworowski 2000).

LNT *ad Absurdum*

The absurdity of the LNT was brought to light in 1987, when minute doses of Chernobyl radiation were used to calculate

that 53,000 people would die of Chernobyl-induced cancers over the next 50 years (Goldman et al. 1987). This frightening death toll calculation was derived simply by multiplying the trifling Chernobyl doses in the United States (0.0046 mSv per person) by the vast number of people living in the Northern Hemisphere, and by a cancer risk factor based on epidemiological studies of 75,000 atomic bomb survivors in Japan.

But the A-bomb survivor data are irrelevant to such estimates because of the difference in the individual doses and dose rates. A-bomb survivors were flashed within less than a second by radiation doses at least 50,000 times higher than any dose that U.S. inhabitants will ever receive over a period of 50 years from the Chernobyl fallout.

We have reliable epidemiological data for a dose rate of perhaps 1,000 or 6,000 mSv per second in Japanese A-bomb survivors. But there are no such data for human exposure at a dose rate of 0.0045 mSv over 50 years, nor will there ever be any. The dose rate in Japan was larger by a factor of about 10^{12} than the Chernobyl dose rate in the United States. Extrapolating over such a vast span is neither scientifically justified nor epistemologically acceptable. It is also morally suspect (Walinder 1995). Indeed, Lauriston Taylor, the late president of the U.S. National Council on Radiological Protection and Measurements, deemed such extrapolations to be a "deeply immoral use of our scientific heritage" (Taylor 1980).

Courtesy of Zbigniew Jaworowski

Prophylactic doses of stable iodine were administered in liquid form (Lugol) within three days of the Chernobyl accident to 18.5 million children and adults in Poland. In agreement with the recommendations of the International Commission on Radiological Protection and the International Atomic Energy Agency (all based on the LNT), the author had recommended this vast operation to the Polish government. Now, he regards this action as futile.

In its document on protection of the public in a major radiation emergency, the International Commission on Radiological Protection recommended the administration of stable iodine, in the form of tablets to be taken before, or as soon as possible after, the start of exposure to radioactive iodine-131 (ICRP 1984). The Commission advised applying this prophylactic measure to everybody—pregnant women, neonates, young infants, and adults—starting at the projected thyroid dose of 50 mSv. This recommendation was based on the LNT dogma. We followed it in Poland.

In the late afternoon of April 28, 1986, we learned from the BBC that there was a reactor accident in Chernobyl. We had seen the radioactive cloud flowing over Poland from east to west, and we had the first data on concentration levels of radioiodine in grass and soil in eastern Poland and in Warsaw. Using these data, I calculated that contamination of thyroid glands of Polish children might reach a limit of 50 mSv, and much more if the situation in Chernobyl and weather conditions further aggravated the situation.

Meaningless Administration of Stable Iodine

In our Institute we had no information from the Soviet Union on the current state of affairs or of any projections regarding the behavior of the destroyed reactor. Therefore, we assumed that in the next few days the radioactivity in the air would increase and cover the whole country. We prepared a portfolio of countermeasures to be implemented by the government.

I presented this project at a meeting of the deputy prime minister, several ministers, and high ranking secretaries of the Central Committee of the Polish United Workers Party, at about 4 A.M. on April 29. The most important measure recommended—and also accepted after a short discussion by this mixture of government and party officials—was stable iodine prophylaxis to protect the thyroid glands of children against iodine-131 irradiation.

Administration of stable iodine in liquid form (as a solution of Lugol) was initiated in the northeastern part of Poland, approximately 38 hours after we discovered the Chernobyl fallout (at approximately midnight on April 28). Treatment was given for the next three days, and about 18.5 million people, including adults, received the stable iodine drug.

We were able to perform this action successfully because we had already made plans for implementing nuclear war emergency measures. In the 1960s, our Institute had recommended that the government prepare for such an event by distributing strategic stores of stable iodine at sites all over the country, as the only reasonable measure against body contamination from fission products. The program was implemented in the early 1970s, and each Polish pharmacy, hospital, and various other institutions had large supplies of iodine.

At the time of the Chernobyl accident, Poland had more than enough iodine ready for use for approximately 100 doses for each Polish citizen. A few years after the catastrophe, it was estimated that in the more contaminated parts of the country the average thyroid radiation dose in the 1- to 10-year-old age group was about 70 mSv, and in about 5 percent of children the maximum dose was about 200 mSv (Krajewski 1991).

Petr Pavlicek/IAEA

The ghost town of Pripyat in July 2005. Its 47,000 residents, including 17,000 children, were completely evacuated the day after the accident in 1986. Pripyat was built in the 1970s to house Chernobyl workers in the 1970s, it was one of the "youngest" towns in the then Soviet Union; the average age of its inhabitants was 26. Today, it is frozen in time. The ferris wheel (center left) is part of an amusement park that never opened. It should be resettled!

A decade later, we learned that among the more than 34,000 Swedish patients who were not suspected of having thyroid cancers, and whose thyroids were irradiated with iodine-131 up to doses of 40,000 mSv (average dose 1,100 mSv), there was no statistically significant increase in thyroid cancers, but rather a 38 percent decrease in their incidence (Dickman et al. 2003, Hall et al. 1996, Holm et al. 1988).

If I knew then what I know today, I would not have recommended to the Polish government such a vast prophylactic action, not because of its allegedly adverse medical effects—there were none (Nauman 1989)—but because its practical positive health effect was meaningless.

Harmful Mass Evacuations

The most nonsensical, expensive, and harmful action, however, was the evacuation of 336,000 people from contaminated regions of the former Soviet Union, where the radiation dose from Chernobyl fallout was about twice the natural dose. Later, this limit was decreased to even below the natural level, and was some five times lower than the radiation dose rate of 5.25 mSv/year at Grand Central Station in New York City, which is constructed with natural granite (Benenson et al. 2006).

Contaminated areas were defined as being those where the average cesium-137 ground deposition density exceeded 37 kBq per square meter. In the Soviet Union, these areas covered 146,100 square kilometers. The Chernobyl fallout of about 185 kBq per square meter or more also covered large areas of Austria, Bulgaria, Finland, Norway, and Sweden (UNSCEAR 2000b). Small areas with Chernobyl fallout, reaching up to about 185 kBq per square meter, were also found in other countries (Great Britain, Greece, Romania, Switzerland, and Turkey (EUR 1996)).

The average radiation doses received in areas with a cesium-137 deposition density of about 37 kBq per square meter were estimated at about 1.6 mSv during the first year after the Chernobyl accident, and the lifetime dose (after 70 years) was predicted to reach 6 mSv (UNSCEAR 1988). This activity level is 10 times lower than the average amount (400 kBq per square meter) of about 50 natural radionuclides present in a 10-cm-thick layer of soil (Jaworowski 2002). The corresponding Chernobyl lifetime radiation dose is 28 times lower than the average natural lifetime dose of about 170 mSv. But the annual dose from 37 kBq of cesium-137 per square meter was similar to the 1 mSv/year dose limit recommended by the International Commission on Radiological Protection for the general population, and this is why it was accepted by the Soviet authorities as a yardstick for remedial measures.

The evacuation caused great harm to the populations of Belarus, Russia, and the Ukraine. It led to mass psychosomatic disturbances, great economic loss and traumatic social consequences. According to Academician Leonid A. Ilyin, the leading Russian authority on radiation protection, the mass relocation was implemented by the Soviet government under the pressure of populists, ecologists, and self-appointed specialists, and it was done against the advice of the best Soviet scientists (Ilyin 1995, Ilyin 1996). The really dangerous air radiation dose rate of 1 Gy/hour on April 26, 1986 (0.01 Gy/hour two days later) covered an uninhabited area of only about 0.5 square kilometers in two patches, reaching up to a distance of 1.8 km southwest of the Chernobyl reactor (UNSCEAR 2000b).

Based on these data, there was no valid reason for the mass evacuation of 49,614 residents from the city of Pripyat and the village of Yanov, situated about 3 km from the burning reactor. In these settlements, the radiation dose rate in the air on April 26, 1986 was 1 mSv/hour (UNSCEAR 2000b), and two days later it was only 0.01 mSv/hour. Thus, with a steadily decreasing radioactivity fallout, the dose rate was not dangerous at all.

However, according to L.A. Ilyin, one of the leaders of the Chernobyl rescue team, there was a danger that the corium (the melted core of the reactor, with a total volume of about 200 cubic meters, a mass of about 540 tons, and a temperature of about 2000°C,) might penetrate down through the concrete floor and spread to rooms below. The team suspected that in these rooms there could have been a great volume of water, with which the corium could come into contact. This would have led to a much more powerful explosion than the initial one, and caused a vastly greater emission of radioactivity, which could have covered Pripyat and Yanow with lethal fall-

Fornalski 2009

Radiation measurement in Pripyat on April 10, 2008 at a sports stadium in the downtown area of the abandoned city, which is about 4 km northwest from the Chernobyl reactor. The dose rate was 0.28 μSv/hour or 2.5 mSv/year. This is more than 10 times lower than the natural radiation in many areas of the world.

out. Therefore, the evacuation of the whole population of these localities was a correct precautionary measure that was carried out in an orderly manner in only two hours.

But the evacuation and relocation of the remaining approximately 286,000 people, of whom there were about 220,000 after 1986 (UNSCEAR 2000b), was an irrational overreaction, induced in part by the influence of the International Commission of Radiological Protection and International Atomic Energy Agency recommendations based on the LNT (Ilyin 1995). The current reluctance of the Ukrainian authorities to resettle the residents back to Pripyat (now a slowly decaying ghost town and tourist attraction) does not seem rational. The radiation dose rate measured on April 10, 2008 in the streets of this city ranged from 2.5 to 8.4 mSv/year, i.e., more than 10 times lower than natural radiation in many regions of the world (Fornalski 2009).

Psychosomatic Epidemics

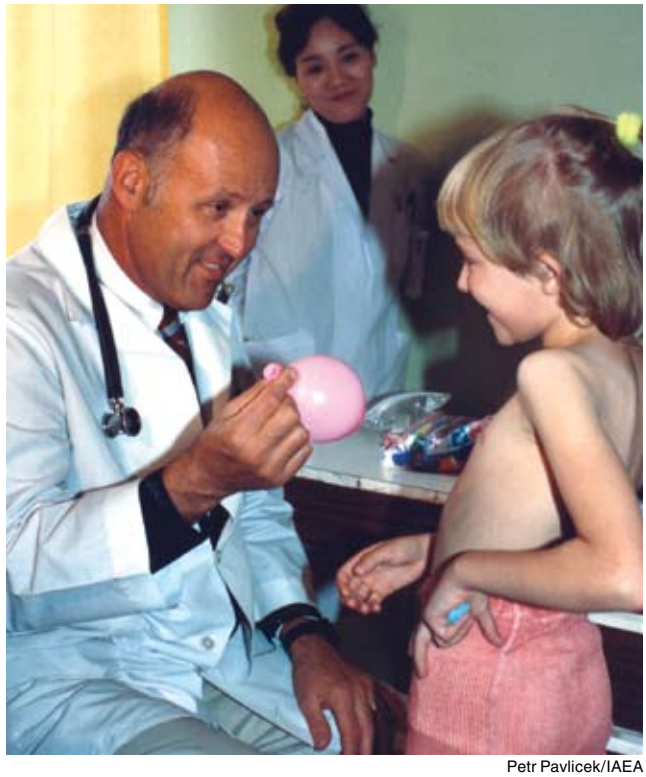
In addition to the 28 fatalities among rescue workers and employees of the power station, caused by very high doses of radiation (2.9-16 Gy), and 3 deaths due to other reasons (UNSCEAR 2000b), the only real adverse health consequences of the Chernobyl catastrophe among approximately 5 million people living in the contaminated regions were the epidemics of psychosomatic afflictions that appeared as diseases of the digestive and circulatory systems and other post-traumatic stress disorders, such as sleep disturbance, headache, depression, anxiety, escapism, learned helplessness, unwillingness to cooperate, overdependence, alcohol and drug abuse, and suicides.

These diseases and disturbances could not have been caused by the minute irradiation doses from the Chernobyl fallout (average dose rate of about 1 to 2 mSv/year), but they were caused by radiophobia, a deliberately induced fear of radiation, aggravated by wrongheaded administrative decisions and even, paradoxically, by increased medical attention, which leads to diagnosis of subclinical changes that persistently hold the attention of the patient.

Bad administrative decisions made several million people believe that they were *victims of Chernobyl,* although the average annual dose they received from Chernobyl radiation was only about one third of the average natural dose. This was the main factor responsible for the economic losses caused by the Chernobyl catastrophe, estimated to have reached $148 billion by 2000 for the Ukraine, and to reach $235 billion by 2016 for Belarus.

Psychological factors and a failure to teach radiological protection in medical school curricula might have led to abortions of wanted pregnancies in Western Europe during the period soon after the accident, where physicians wrongly advised patients that Chernobyl radiation posed a health risk to unborn children. However, numerical estimates of this effect (Ketchum 1987, Spinelli and Osborne 1991) cast doubt on this assumption.

Similarly uncertain are estimates of the number of decisions against conception probably taken in Europe during the first few months after the accident (Trichopoulos et al. 1987). This problem was discussed in 1987 by an IAEA Advisory Group, which concluded that medical practitioners having direct contact with the population at large are among the most important persons who might develop the right perception of risks in nuclear emergencies, prevent social panic and overreactions, and help to ensure the rational behavior in the society.



Petr Pavlicek/IAEA

A doctor from the IAEA International Chernobyl Project examines a child in Ukraine, 1990. Although the average radiation dose to the several million people around Chernobyl was only about one third of the average annual dose from natural radiation, the panic and radiophobia after the accident created a class of "Chernobyl victims," with many disorders related to radiophobia, not actual radiation dose.

Elisabeth Zeiler/IAEA

A group of villagers being interviewed for the IAEA epidemiological study during the International Chernobyl Assessment Project.

After the Chernobyl accident the public very often turned for help to medical practitioners, but physicians were unable to provide realistic advice, even on minor problems. This was because medical curricula did not at that time prepare doctors for nuclear emergencies. In none of the nine countries represented at the meeting were the principles of radiobiology and radiation protection included in medical school curricula (IAEA 1987). Lack of knowledge in this important group was among the factors that increased public anxiety and stress. It seems that now, two decades later, the situation in this respect is very much the same.

Effects of Chernobyl Fallout on the Population

In 2000, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2000b) and in 2006, the United Nations Chernobyl Forum (a group composed of representatives from eight U.N. organizations, the World Bank, and the governments of Belarus, Russia, and the Ukraine) stated in their documents that, except for thyroid cancers in the population of highly contaminated areas, there was no observed increase in the incidence of solid tumors and leukemia, and no observed increase in genetic diseases. An increase in registration of thyroid cancers in children under 15 years old was first found in 1987, one year after the accident, in the Bryansk region of Russia, and the greatest incidence, of 0.027 percent of children under 15 was found in 1994.

Both of these studies were made too early to be in agreement with what we know about radiation-induced cancers. The mean latency period for malignant thyroid tumors in adults and children exposed to external and internal medical irradiation with less than 20 to more than 40 Gy is about 28 years (Kikuchi et al. 2004, UNSCEAR 2000b).

Kikuchi et al. tried to explain the discrepancy between the clinical experience and the Chernobyl findings with some exotic ideas, such as, for example, radiation leakage or other environmental conditions; exposure to carcinogens that occurred near Chernobyl prior to the nuclear accident; and a genetic predisposition of the population to thyroid cancer. However, the serendipitous effect of mass screening and diagnosis, already suspected in 1987, is a more likely explanation.

The Clinical Screening Effect

The number of 4,000 new thyroid cancers registered among the children from Belarus, Russia, and the Ukraine should be viewed in the context of the extremely high occurrence of these dormant subclinical malignant tumors that contain transformed tumor cells, which are quite common in the world population (Akslen and Naumov 2008, Weinberg 2008). For example, the incidence of occult thyroid cancers, varies from 5.6 percent in Colombia, 9.0 percent in Poland, 9.3 percent in Minsk (Belarus), 13 percent in the United States, and 28 percent in Japan, to 35.6 percent in Finland (Harach et al. 1985, Moosa and Mazzaferri 1997). In Finland, these dormant thyroid cancers are observed in 2.4 percent of children (Harach et al. 1985), that is, some 90 times more than the maximum observed in the Bryansk region, the most contaminated in Russia.

In Minsk, Belarus, the normal incidence of occult thyroid cancers is 9.3 percent (Furmanchuk et al. 1993). The "Chernobyl" thyroid cancers are of the same histological type and are similar in invasiveness to the occult cancers (Moosa and Mazzaferri 1997, Tan and Gharib 1997). Since 1995, the number of regis-

Petr Pavlicek/IAEA

The new town of Slavutich, 50 km from Chernobyl, which was built for the displaced persons of Chernobyl.

tered cancers has tended to decline. This is not in agreement with what we know about radiation-induced thyroid cancers, whose latency period is about 5-10 years after irradiation exposure (Inskip 2001), and whose risk increases until 15-29 years after exposure (UNSCEAR 2000a).

In the United States the incidence rate of thyroid tumors detected between 1974 and 1979 during a screening program, was 21 times higher than before the screening (Ron et al. 1992), an increase similar to that observed in three former Soviet countries. It appears that the increased registration of thyroid cancers in contaminated parts of the countries affected by Chernobyl is a classical screening effect.

According to the regulations of the Belarusian Ministry of Health, the thyroids of all people who were younger than 18 in 1986 and those of each inhabitant of contaminated areas must be diagnosed every year (Parshkov et al. 2004). More than 90 percent of children in contaminated areas are now examined for thyroid cancers every year with ultrasonography and other methods. It is obvious that such a vast-scale screening, probably the greatest in the history of medicine, resulted in finding thousands of the occult cancers, or incidentalomas, expanded to forms detectable by modern diagnostic methods that were not in routine use in the Soviet Union before 1986.

Data for the past 20 years, published by Ivanov et al. in 2004 and cited in the UNSCEAR and Chernobyl Forum documents (Forum 2005, Forum 2006, Ivanov et al. 2004, UNSCEAR 2008) show, in comparison to the Russian general population, that there was a 15 to 30 percent lower mortality from solid tumors among the Russian Chernobyl emergency workers, and a 5 percent lower average solid tumor incidence among the population of the Bryansk district, the most contaminated in Russia (Figures 2 and 3).

In the most exposed group of these people (with an estimated average mean radiation dose of 40 mSv), a 17 percent decrease in the incidence of solid tumors of all kinds was found. In the Bryansk district, the leukemia incidence is not higher than in the Russian general population. According to UNSCEAR (2000b), no increase in birth defects, congenital malformations, stillbirths, or premature births could be linked to radiation exposures caused by the Chernobyl fallout. The final conclusion of the UNSCEAR 2000 report is that the population of the three main contaminated areas, with a cesium-137 de-

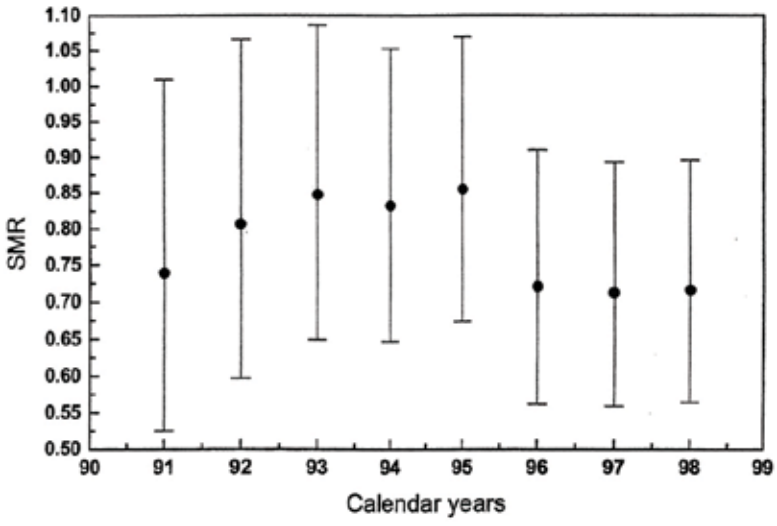


Figure 2
STANDARD MORTALITY RATIOS FOR SOLID CANCERS AMONG THE RUSSIAN EMERGENCY WORKERS

The values of standard mortality ratios (SMR) indicate how the cancer mortality of emergency workers differs from that of the general population of Russia, which was used as a control group (SMR = 1.0). The deficit of cancers among these workers between 1990 and 1999, ranged between 15 percent and 30 percent.

Source: Ivanov et al. 2004, p. 225

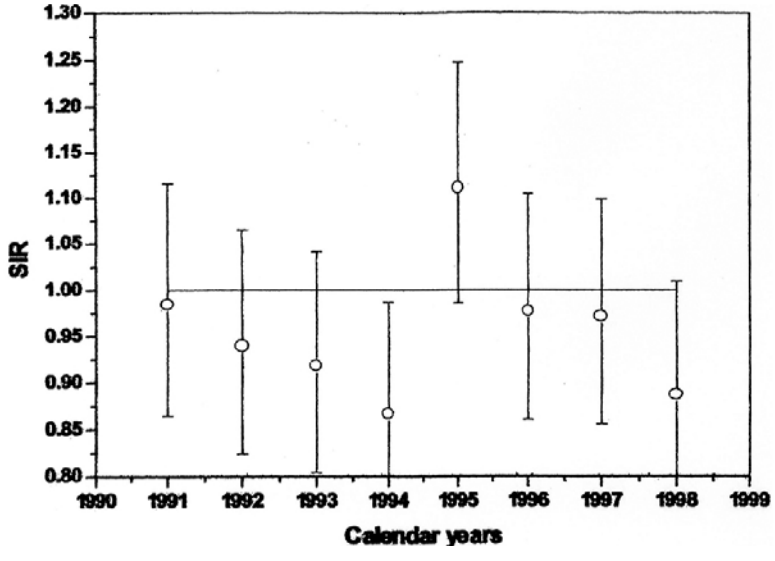


Figure 3
STANDARD INCIDENCE RATIOS FOR SOLID CANCERS IN THE BRYANSK REGION OF RUSSIA

The average deficit of cancers in the inhabitants of the Bryansk region was 5 percent, and in the most exposed group (mean radiation dose of 40 mGy) it was 17 percent.

Source: Ivanov et al. 2004, pp. 373-374

IAEA

Checking radiation in a house in the village of Babovichi, Russian Federation, in August 1990.

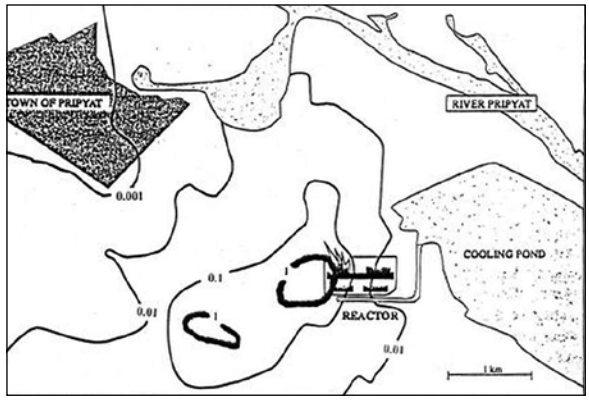


Figure 4
CHERNOBYL RADIATION AFTER THE ACCIDENT

The radiation dose rate in air on April 26, 1986 in the local area of the Chernobyl reactor. Units of the isolines are sieverts per hour. Only in the two patches inside the 1 Sv isolines were the dose rates life endangering, during the first two days. After two days, the dose rates decreased about 100 times.

Source: Adapted from UNSCEAR 2000

position density greater than 37 kBq/square meter, need not live in fear of serious health consequences, and forecasts that generally positive prospects for the future health of most individuals should prevail.

The publications of the U.N. Chernobyl Forum present a rather balanced overview of the Chernobyl health problems, but with three important exceptions. The first (mainly after Cardis et al. 2005) is ignoring or downplaying the effect of screening for thyroid cancers in about 90 percent of the population (see discussion above), and interpreting the results with a linear no-threshold dose-response model.

The paper by Cardis et al., however, was criticized for this interpretation, as not confirmed by the data presented and attributing most of the thyroid cancers to radiation (Scott 2006). Both the Chernobyl Forum and the 2005 and 2006 papers by Cardis et al. ignore the aforementioned fundamental problem of occult thyroid cancers in the former Soviet Union and elsewhere in Europe.

The incidence of thyroid occult cancers increased rapidly after the advent of new ultrasonography diagnostics (Topliss 2004), reaching up to 35.6 percent (see above). This incidence is more than 1,300 times higher than the maximum thyroid cancer incidence found in the Bryansk region of Russia in 1994 (UNSCEAR 2000b), which implies a vast potential for bias. It seems that there still has not been an epidemiological study of the temporal changes of intensity of thyroid screening in the former Soviet Union. The conclusions of the epidemiological studies that did not take into account these changes in screening may be invalid.

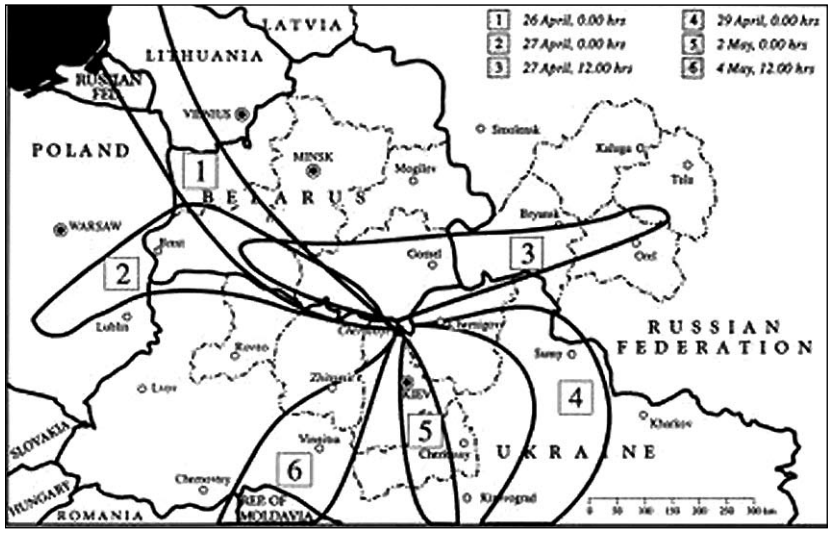


Figure 5
RADIATION PLUMES AFTER THE CHERNOBYL ACCIDENT

The plumes of radiation formed by meteorological conditions on the days following March 26, 1986. The dates and times are indicated in Greenwich Mean Time.

Source: Adapted from UNSCEAR 2000

In the Bryansk region of Russia, the thyroid cancer incidence was found to be 45 percent higher in males and 90 percent higher in females, than for the Russian population as a whole. However, when dose-response analyses were performed, using external and internal comparisons, no positive association of thyroid cancers with radiation dose was observed. Instead, a negative association was observed, i.e. a hormetic effect (Iva-

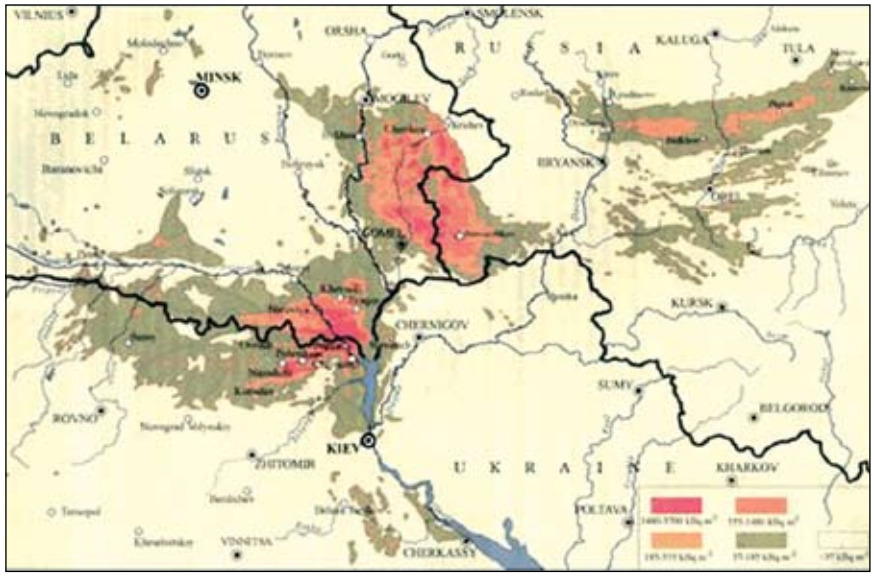


Figure 6
SURFACE GROUND MAP OF CESIUM-137 RELEASED IN THE CHERNOBYL ACCIDENT

Source: Adapted from UNSCEAR 2000

nov et al. 2004). These results strongly suggest that the increased cancer rates in Bryansk (and, by implication, in other contaminated regions) compared with general population rates are the result of thyroid cancer screening and better reporting, rather than radiation exposure (Ron 2007).

Even more important a problem in the U.N. Chernobyl Forum report was that it ignored the decrease of thyroid cancer incidence of up to 38 percent, after the iodine-131 treatment of many thousands of non-cancer patients with thyroid radiation doses similar to, or higher than, those from the Chernobyl fallout (Dickman et al. 2003, Hall et al. 1996, Holm et al. 1991, and Holm et al. 1988).

The second problem with the Chernobyl Forum report is estimation of deaths among the patients with acute radiation disease. From among 134 persons with this disease who had been exposed to extremely high radiation doses, 31 died soon after the accident. Among the 103 survivors, 19 died before 2004. Most of these deaths were caused by such disorders as lung gangrene, coronary heart disease, tuberculosis, liver cirrhosis, fat embolism, and other conditions that can hardly be defined as caused by ionizing radiation. Nevertheless, the Chernobyl Forum presents them as a resulting from high irradiation and sums them up to arrive at a total of approximately 50 victims of acute irradiation.

After many summers, all the 103 survivors will eventually die. The Chernobyl Forum philosophy would then count them all, yielding a round total of 134 victims of high irradiation. In fact, the mortality rate among these 103 survivors was 1.08 percent per year, that is, less than the average mortality rate of 1.5 percent in the three affected countries in 2000 (GUS 1991).

And finally, the third Chernobyl Forum "problem" is its projections of future fatalities caused by low-level Chernobyl radiation, from 4,000 up to exactly 9,935 deaths. These numbers are not based on epidemiological data of cancer mortality observed during the past 20 years by Ivanov et al. No such increase was demonstrated by Ivanov et al. (2004), but rather a decrease of solid tumor and leukemia deaths among exposed people. These epidemiological data, rather than the LNT assumption, should be used as the basis for a realistic projection of the future health of the millions of people officially labeled "victims of Chernobyl."

However, the Chernobyl Forum instead chose to use the LNT radiation risk model (ICRP 1991) and performed a simplistic arithmetical exercise, multiplying small doses by a great number of people, and including a radiation risk factor deduced from the Hiroshima and Nagasaki studies.

This is an entirely fallacious method. People living in areas highly contaminated by the Chernobyl fallout were irradiated during a protracted time. The dose rates in Hiroshima and Nagasaki, in contrast, were higher by a factor of about 10^{11} than the average dose rate of the Chernobyl victims that was used in the Forum's projections. The result of this exercise is nothing more than a fantastic lie.

Several scientific and radiation protection bodies, including UNSCEAR, the Health Physics Society (Mossman et al. 1996), the French Academy of Science (Tubiana 1998), and even the chairman of the International Commission on Radiological Protection (Clarke 1999), advised against making such calculations. Merely publishing these numbers is harmful and petrifies the Chernobyl fears.

Any efforts to explain the intricacies of radiation risk assessments to the public, or to compare these numbers with the much higher level of spontaneous cancer deaths, will be futile exercises. The past 20 years has proved that such efforts are worthless. Making such calculations keeps a lot of people busy and well, but has no relationship to reality and honesty. The Forum's elucubrations, however, pale in comparison with recent estimates by other bodies such as Greenpeace (Greenpeace 2006, Vidal 2006), predicting the incidence of millions of Chernobyl cancers and hundreds of thousands of deaths.

Remove the Chernobyl Restrictions!

It is reassuring, however, that 16 years after the Chernobyl catastrophe, another group, composed of four U.N. organizations—the United Nations Development Programme (UNDP), the World Health Organization (WHO), the U.N. International Children's Emergency Fund (UNICEF) and the U.N. Office for the Coordination of Humanitarian Affaires (UNOCHA)—dared to state in its 2002 report, based on UNSCEAR studies, that a great part of the billions of dollars used to mitigate the consequences of the Chernobyl accident was spent incorrectly. The

dollars spent in these efforts did not improve, but actually worsened, a deteriorating situation for 7 million so-called "victims of Chernobyl" and solidified the psychological effects of the catastrophe and the wrong decisions of the authorities.

The report (UNDP 2002) recommended that the three post-Soviet countries and the international organizations abandon the current policy. The misguided basis of this policy, i.e. expectation of mass radiation health effects, was responsible for the enormous and uselessly expended resources sacrificed for remediation efforts. Instead, the report presented 35 practical recommendations needed to stop the vicious cycle of Chernobyl frustrations, social degradation, pauperization, and the epidemic of psychosomatic disorders. The recommendations suggest a reversal of the policy of concentrating attention on nonexistent radiation hazards, and propose that relocated individuals be allowed to return to their old settlements. That is, that essentially all of the restrictions should be removed.*

But here we enter a political mine-field. How well will people accept losing the mass benefits (equivalent to about $40 a month) that they poetically call a "coffin bonus"? How can it be explained to them that they were made to believe that they were the "victims" of a nonexistent hazard; that the mass evacuations were an irresponsible error; that for 20 years, people were unnecessarily exposed to suffering and need; that vast areas of land were unnecessarily barred from use; and that their countries' resources were incredibly squandered?

One can read in many publications that the Chernobyl catastrophe had serious political implications and was an important factor in the dismantling of the Soviet Union and in attempts to control nuclear arms. As Mikhail Gorbachev stated:

> The nuclear meltdown at Chernobyl 20 years ago even more than my launch of prerestroika, was perhaps the real cause of the collapse of the Soviet Union five years later. Chernobyl opened my eyes like nothing else: it showed the horrible consequences of nuclear power. One could now imagine much more clearly what might happen if a nuclear bomb exploded—one SS-18 rocket could contain a hundred Chernobyls. Unfortunately, the problem of nuclear arms is still very serious today (Gorbachev 2006).

Petr Pavlicek/IAEA

A farmer in Jelno, July 2005. Jelno is a village 300 km from Chernobyl, which was affected by contamination from the accident because of weather conditions. Now the population has gone back to the land. "Social upheaval, however," the IAEA noted, "has left farmers with only primitive tools of the trade."

Petr Pavlicek/IAEA

"Jelno is a town where time has stood still," the IAEA noted, unlike the new settlement of Slavutich.

Would fulfilling the recommendations of the United Nations Development Programme (UNDP) 2000 report again result in a political catharsis and perhaps induce violent reactions? Probably not in Russia, where a more rational approach to Chernobyl prevails. But the political classes of Belarus and Ukraine

* On July 23, 2010, Belarus, Russian, and Polish news agencies, including some radio stations and TV channels, announced that this last recommendation was fulfilled by the Belarus government, which decided to repopulate 2,000 villages in the "contaminated areas." Assuming 100 residents for one village, this would amount to about 200,000 people. It seems that preparations for this move started in about 2004, and already several thousands have come back to their old settlements. The Belarus government deserves commendation for its courage to stand up to the Chernobyl hysteria, which for years has been cultivated by Greenpeace and other Greens. Its decision brings us back to normalcy. See "Belarus Repopulating Exclusion Zone," this issue.

have for years demonstrated a much more emotional approach. When the UNSCEAR 2000a report, documenting the low incidence of serious health hazards resulting from the Chernobyl accident, was presented to the U.N. General Assembly, the Belarus and Ukraine delegations lodged a fulminating protest. This set the stage for the Chernobyl Forum in 2002, and helped to focus its agenda.

Today, the Chernobyl rumble and emotions are beginning to settle down. In the centuries to come, the catastrophe will be remembered as a proof that nuclear power is a safe means of energy production. It even might change the thinking of the International Commission on Radiological Protection.

Zbigniew Jaworowski is a multidisciplinary scientist who has published more than 300 scientific papers, four books, and scores of popular science articles, including many in 21st Century. *He has been a member of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) since 1973, and served as its chairman from 1980-1982.*

This article is adapted from the author's "Chernobyl Disaster and LNT," in Dose-Response, *Vol. 8, No. 2, 2010.*

References

ACS, 2009. "Tumor markers." American Cancer Society, http://www.cancer.org/docroot/PED/content/PED_2_3X_Tumor_Markers.asp.

L.A. Akslen and G.N. Naumov, 2008. "Tumor dormancy—from basic mechanisms to clinical practice." *Acta Pathologica, Microbiologica et Immunologica Scandinavica,* Special Issue: "Tumor Dormancy," Vol. 116, pp. 545-547.

D. Altius, 2008. "Natural Disaster." http://www.altiusdirectory.com/Science/natural-disaster.html.

H.M. ApSimon, A.J.H. Goddard, J. Wrigley, and S. Crompton, 1985. "Long-range atmospheric dispersion of radioisotopes: II. Application of the MESOS model." *Atmospheric Environment* Vol. 19, pp. 113-125.

H.M. ApSimon and J.J.N. Wilson, 1987. "Modelling Atmospheric dispersal of the Chernobyl release across Europe." *Boundary-Layer Meteorology,* Vol. 41, pp. 123-133.

K. Becker, 1996. "Some economical, social, and political consequences in Western Europe." Paper No. IAEA-CN-63/196. International Conference One Decade after Chernobyl: Summing up the Consequences of the Accident.

M.L. Bell and D.L. Davis, 2001."Reassessment of the lethal London fog of 1952: Novel indicators of acute and chronic consequences of acute exposure to air pollution." *Environmental Health Perspectives Supplements* http://www.ehponline.org/members/2001/suppl-3/389-394bell/bell-full.html.

W. Benenson, J.W. Harris, H. Stocker, and H. Lutz, 2006. *Handbook of Physics.* Springer.

A. Berrington, S.C. Darby, H.A. Weiss, and R. Doll, 2001. "100 years of observation on British radiologists: Mortality from cancer and other causes 1897-1997." *The British Journal of Radiology,* Vol. 74, pp. 507-519.

E. Cardis et al., 2007. "The 15-country collaborative study of cancer risk among radiation workers in the nuclear insustry: Estimates of radiation-related cancer risks." *Radiation Research,* Vol. 167, pp. 396-416.

E. Cardis et al., 2006. "Estimates of the cancer burden in Europe from radioactive fallout from the Chernobyl accident." *International Journal of Cancer,* Vol. 119, pp. 1224-1235.

E. Cardis et al., 2005. "Risk of thyroid cancer after exposure to ^{131}I in childhood." *J of National Cancer Institute,* Vol. 97, pp. 724-732.

W.L. Chen, Y.C. Luan, et al., 2004. "Is chronic radiation an effective prophylaxis agains cancer?" *Journal of American Physicians and Surgeons,* Vol. 9, pp. 6-10.

G.C. Christensen, 1989. "The impact of the Chernobyl accident on Norway." In *7th IRPA International Congress,* Vol. 2, pp. 1483-1486. Available at http://www2000.irpa.net/irpa7/cdrom/VOL.3/S3_106.PDF.

R. Clarke, 1999. "Control of low-level radiation exposure: Time for a change? *Journal of Radiological Protection,* Vol. 19, pp. 107-115.

B.L. Cohen, 2000. "The recent cancer risk from low level radiation: A review of recent evidence." *Medical Sentinel,* Vol. 5, pp. 128-131, available at: http://www.haciendapub.com/article50.html.

J.R. Davis, 2009. "Postwar relations: the long climbing from Yalta and Potsdam to Gdansk and the round table." *Polish Review,* 77 pp.

J.R. Davis, G. Domber, M. Jarzab, P. Sowinski, et al., 2006. "Toward the Victory of Solidarity: Correspondence between the American Embassy in Warsaw and the State Department, January-September 1989" (in Polish). Instytut Studiów Politycznych PAN.

V.R. Dhara and R. Dhara, 2002. "The Union Carbide Disaster in Bhopal: A review of Health Effects." *Archives of Environmental Health,* Vol. 57, pp. 391-404.

J.E. Dibb, P.A. Mayewski, C.S. Buck, and S.M. Drumey, 1990. "Beta radiation from snow." *Nature,* Vol. 345, p. 25.

P.W. Dickman, L.E. Holm, G. Lundell, and P. Hall, 2003. "Thyroid cancer risk after thyroid examination with ^{131}I: A population-based cohort study in Sweden." *International Journal of Cancer,* Vol. 106, pp. 580-587.

EUR, 1996. "Preliminary version of the total Caesium-137 deposition map taken from the "Atlas of Caesium deposition on Europe after the Chernobyl accident." European Commission Office of Publication, Luxembourg, EUR report 16733.

K.W. Fornalski, 2009. "What is the radiation level now in Chernobyl?" (in Polish). Press Conference of Society of Ecologists for Nuclear Energy (SEREN), Polish Press Agency, Warsaw, April 24, 2009.

K.W. Fornalski and L. Dobrzynski, 2009. "Healthy worker effect and nuclear industry workers." *Dose-Response,* Vol. 8, No. 2: pp. 125-147.

Forum, 2005. "Chernobyl's legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine," 57 pp. The Chernobyl Forum.

Forum, 2006. "Health Effects of the Chernobyl Accident and Special Health Care Programmes." Report of the U.N. Chernobyl Forum Expert Group "Health." World Health Organization.

N.A. Frigerio, K.F. Eckerman, and R.S. Stowe, 1973. "The Argonne Radiological Impact Program (ARIP)." Part I. "Carcinogenic Hazard from Low-level, Low-rate Radiation," 35 pp. Argonne National Laboratory.

N.A. Frigerio and R.S. Stowe, 1976. "Carcinogenic and genetic hazard from background radiation." In *Biological and Environmental Effects of Low-Level Radiation,* Vol. 2, pp. 385-393. IAEA-SM-202/805. International Atomic Energy Agency, Vienna, Austria.

A.W. Furmanchuk, N. Roussak, and C. Ruchti, 1993. "Occult thyroid carcinomas in the region of Minsk, Belarus. An autopsy Study of 215 patients." *Histopathology,* Vol. 23, pp. 319-325.

M. Goldman, R.J. Catlin, and L. Anspaugh, 1987. "Health and Environmental Consequences of the Chernobyl Nuclear Power Plant Accident, 289 pp. U.S. Department of Energy.

M. Gorbachev, 2006. "Turning point at Chernobyl." http://www.project-syndicate.org/commentary/gorbachev3/English.

Greenpeace, 2006. "Chernobyl death toll grossly underestimated." April 18, 2006. Greenpeace International. http://www.commondreams.org/cgi-bin/print.cgi? file=/headlines06/0325-05.htm.

GUS, 1991. *Statistical Yearbook of the Republic of Poland* (in Polish). Główny Urzad Statystyczny, Warsaw, Poland.

P. Hall, A. Mattsson, and J.D. Boice, Jr., 1996. "Thyroid cancer after diagnostic administration of iodine-131." *Radiation Research,* Vol. 145, pp. 86-92.

H.R. Harach, K.O. Franssila, and V.M. Wasenius, 1985. "Occult papillary carcinoma of the thyroid—A 'normal' finding in Finland. A systematic study." *Cancer,* Vol. 56, pp. 531-538.

T. Henriksen and G. Saxebol, 1988. "Fallout and radiation doses in Norway after the Chernobyl accident." *Environment International,* Special Issue: Chernobyl Accident: Regional and Global Impacts, Guest Editor, Zbigniew Jaworowski Vol. 14, pp. 157-163.

S. Hirschberg, G. Spikerman, and R. Dones, 1998. "Severe accidents in the energy sector." Paul Scherrer Institute, Switzerland, Report No. PSI- 98-16.

L.E. Holm, P. Hall, K. Wiklud, G. Lundell, G. Berg, G. Bjelkwengren, E. Cederquist, U.B. Ericsson, L.G. Larsson, M. Lidberg, S. Lindberg, J. Tennvall, H. Wicklund, and J.J.D. Boice, 1991. "Cancer risk after iodine-131 therapy for hyperthyroidism." *Journal of the National Cancer Institute,* Vol. 83, pp. 1072-1077.

L.E. Holm, K. Wiklud, G. Lundell, A. Bergman, G. Bjelkwengren, E. Cederquist, U.B. Ericsson, L.G. Larsson, M. Lidberg, S. Lindberg, H. Wicklund, and J.J. D. Boice, 1988. "Thyroid cancer after diagnostic doses of iodine-131: A retrospective cohort study." *Journal of the National Cancer Institute,* Vol. 80, pp. 1133-1138.

S-Lea Hwang, 2008. "Estimates of relative risks for cancers in a population after prolonged low-dose-rate radiation exposure: A follow-up assessment from 1983 to 2005." *Radiation Research,* Vol. 170, pp. 143-148.

IAEA, 1987. "Conclusions and Recommendations." Advisory Group Meeting on Introducing the Basic Principles of Assessment and Treatment of Radiation Injuries into the Basic and Post-Graduate Training of Medical and Paramedical Personnel.

IAEA, 2008. "Climate Change and Nuclear Power 2008." Brochure, pp. 60. International Atomic Energy Agency http://www.iaea.org/OurWork/ST/NE/Pess/

assets/ 08-33461-CCNP-Brochure.pdf.

ICRP, 1959. *Recommendations of the International Commission on Radiological Protection.* Pergamon Press.

ICRP, 1984. *Protection of the public in the event of major radiation accidents: Principles for planning.* Pergamon Press.

ICRP, 1991. *1990 Recommendations of the International Commission on Radiological Protection.* ICRP Publication 60. Pergamon Press.

B. Idas and J. Myhre, 1994. "Countermeasures in Norway are exaggerated" (in Norwegian). *Aftenposten,* Aug. 10, 1994.

L.A. Ilyin, 1996. Personal communication to Z. Jaworowski, Warsaw, December 23, 1996.

_____, 1995. *Chernobyl: Myth and Reality*. Megapolis.

P.D. Inskip, 2001. "Thyroid cancer after radiotherapy for childhood cancer." *Medical and Pediatric Oncology,* Vol. 36, pp. 568-572.

V.K. Ivanov, A.F. Tsyb, S. Ivanov, and V. Pokrovsky, 2004. *Medical Radiological Consequences of the Chernobyl Catastrophe in Russia.* NAUKA.

Z. Jaworowski, 1988. "Chernobyl Proportions," Editorial. *Environ International,* Special Issue: Chernobyl Accident: Regional and Global Impacts, guest ed. Zbigniew Jaworowski, Vol. 14, pp. 69-73.

_____, 1999. "Radiation risk and ethics." *Physics Today,* Vol. 52, pp. 24-29.

_____, 2000. "Beneficial Radiation and Regulations." IOCONE 8 8th International Conference on Nuclear Engineering, April 2-6, 2000, Baltimore.

_____, 2002. "Ionizing radiation in the 20th Century and beyond." *Atomwirtschaft—Atomtechnik,* Vol. 47, pp. 22-27.

_____, 2009. "Radiation Hormesis: A Remedy for Fear." *BELLE Newsletter,* Vol. 15, pp. 14-20.

Z. Jaworowski and L. Kownacka, 1994. "Nuclear weapon and Chernobyl debris in the troposphere and lower stratosphere." *The Science of the Total Environment,* Vol. 144, pp. 201-215.

L.E. Ketchum, 1987. "Lessons of Chernobyl: SNM members try to decontaminate the world threatened by fallout—Experts face chanllenge of educating public about risk and radiation." *Journal of Nuclear Medicine,* Vol. 28, pp. 933-942.

S. Kikuchi, N. Perrier, P. Ituarte, A.E. Siperstein, Q-Y Dug, and O.H. Clark, 2004. "Latency period of thyroid neoplasia after radiation exposure." *Annals of Surgery,* Vol. 239, pp. 536-543. Available at http://www.pubmedcentral.nih.gov/articlerender. fcgi?artid=1356259&rendertype=table&id=t1356251-1356214

P. Krajewski, 1991. "Estimate of thyroid committed dose equivalents in Polish population due to iodine-131 intake after the Chernobyl catastrophe. Determination of effectiveness of thyroid blocking with sodium iodide." (in Polish). *Polish Journal of Endocrinology,* Vol. 42, pp. 189-202.

T.D. Luckey, 2003. "Radiation hormesis overview." *RSO Magazine,* Vol. 8, pp. 22-41.

P. McCully, 1998. "When things fall apart: The technical failures of large dams" (Chapter 4). In *Silenced Rivers: The ecology and Politics of Large dams,* p 200. South Asia Books

M. Moosa and E.L Mazzaferri, 1997. "Occult thyroid carcinoma." *The Cancer Journal,* Vol. 10, pp. 180-188.

S.M.J.Mortazawi, M. Ghiassi-Neyad, P.A. Karam, T. Ikushima, A. Niroomand-rad, and J.R. Cameron, 2006. "Cancer incidence in areas with elevated levels of natural radiation." *International Journal of Low Radiation,* Vol. 2, pp. 20-27.

K.L. Mossman, M. Goldman, F. Masse, W.A. Mills, K.J. Schiager, and R.L. Vetter, 1996. "Radiation risk in perspective." Health Physics Society Position Statement, March 1996, Vol. 12 March 1996, pp. 1-2. http://www.physics.isu.edu/radinf/hprisk.htm.

G. Murphy, 2009. "A final warning for humanity—or James Lovelock?" A review of James Lovelock, *The Vanishing Face of Gaia: A Final Warning.* Basic Books, 2009, in *21st Century Science & Technology, Vol. 22, pp. 63-64.*

J. Nauman, 1989. "Potassium iodide prophylaxis in Poland: Review of far field experience." In E. Rubery and E. Smales (eds.) *Iodine Prophylaxis Following Nuclear Accidents,* pp. 135-140. Pergamon Press.

E.M. Parshkov, V.A. Sokolov, A.F. Tsyb, A.D. Proshin, and J.G. Barnes, 2004. "Radiation-induced thyroid cancer: What we know and what we really understand." *Intl J Low Radiation,* Vol. 1, pp. 267-278.

J.C. Philippot, 1990. "Fallout in snow." *Nature,* Vol. 348, pp. 21.

E. Ron, 2007. "Thyroid cancer incidence among people living in areas contaminated by radiation from the Chernobyl accident." *Health Physics,* Vol. 93, pp. 502-511.

E. Ron, J. Lubin, and A.B. Schneider, 1992. "Thyroid cancer incidence." *Nature,* Vol. 360, p. 113.

A. Salo and J. Daglish, 1988. "Response to an accident in theory and in practice." *Environment International,* Special Issue on "Chernobyl Accident: Regional and Global Impacts," Guest Editor Zbigniew Jaworowski, Vol. 14, pp. 185-200.

B.E. Scott, 2006. "Correspondence Re: Risk of thyroid cancer after exposure to ^{131}I in childhood." *Journal of the National Cancer Institute,* Vol. 98, pp. 561.

A. Spinelli and J.F. Osborne, 1991. "The effects of the Chernobyl explosion on induced abortion in Italy." *Biomedicine & Pharmacotherapy,* Vol. 45, pp. 243-247.

G.H. Tan and H. Gharib, 1997. "Thyroid incidentalomas: Management approaches to nonpalpable nodules discovered incidentally on thyroid imaging." *Annals of Internal Medicine,* Vol. 126, pp. 226-231.

L.S. Taylor, 1980. "Some non-scientific influences on radiation protection standards and practice." 5th International Congress of the International Radiation Protection Association.

D. Topliss, 2004. "Thyroid incidentaloma: The ignorant in pursuit of impalpable." *Clinical Endocrinology,* Vol. 60, pp. 18-20.

D. Trichopoulos, X. Zavitsanos, C. Koutis, P. Drogari, C. Proukakis, and E. Petridou, 1987. "The victims of Chernobyl in Greece: Induced abortions after the accident." *British Medical Journal,* Vol. 295, p. 1100.

M. Tubiana, 1998. "The report of the French Academy of Science: 'Problems associated with the effects of low doses of ionizing radiation.' *Journal of Radiological Protection,* Vol. 18, pp. 243-248.

UNDP, 2002. *The Human Consequences of the Chernobyl Nuclear Accident: A strategy for Recovery,* 75 pp. United Nations Development Programme (UNDP) and the UN Children's Fund (UNICEF) with the support of the UN Office for Co-ordination of Humanitarian Affairs (OCHA) and WHO.

UNSCEAR, 1958. *Report of the United Nations Scientific Committee on the Effects of Atomic Radiation,* 228 pp. United Nations.

UNSCEAR, 1982. *Ionizing Radiation: Sources and Biological Effects,* 773 pp. United Nations Scientific Committee on the Effects of Atomic Radiation. United Nations.

UNSCEAR, 1988. *Sources, Effects and Risks of Ionizing Radiation. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation,* 647 pp. United Nations.

UNSCEAR, 1993. *Sources and Effects of Ionizing Radiation,* 922 pp. United Nations Scientific Committee on the Effects of Atomic Radiation. United Nations.

UNSCEAR, 1994. "Annex B: Adaptive responses to radiation in cells and organisms." In *Sources and Effects of Ionizing Radiation. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation,* pp 185-272. United Nations.

UNSCEAR, 1998. *Exposures from man-made radiation.* Report of United Nations Scientific Committee on the Effects of Atomic Radiation, 130 pp. United Nations.

UNSCEAR, 2000a. *Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation,* UNSCEAR 2000, Report to the General Assembly. United Nations.

UNSCEAR, 2000b. *Sources and Effects of Ionizing Radiation.* United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000, Report to the General Assembly. "Annex J: Exposures and Effects of the Chernobyl Accident," pp. 451-566. United Nations.

UNSCEAR, 2001. *Hereditary Effects of Radiation.* "Scientific annex" of UNSCEAR 2001 report to the General Assembly, 224 pp. United Nations Scientific Committee on the Effects of Atomic Radiation. United Nations.

UNSCEAR, 2008. *Health effects due to radiation from the Chernobyl accident.* Draft report A/AC.82/R.673, 220 pp. United Nations Scientific Committee on the Effects of Atomic Radiation. United Nations.

J. Vidal, 2006. "UN accused of ignoring 500,000 Chernobyl deaths." *The Guardian* (U.K.) March 25, 2006. http://www.commondreams.org/cgi-bin/print.cgi?file= /headlines06/0325-05.htm.

G. Walinder, 1995. "Has radiation protection become a health hazard?" The Swedish Nuclear Training & Safety Center.

E.W. Webster, 1993. "Hormesis and radiation protection." *Investigative Radiology,* Vol. 28, pp. 451-453.

L. Wei, Y. Zha, Z. Tao, W. He, D. Chen, and Y. Yuan, 1990. "Epidemiological investigation of radiological effects in high background radiation areas of Yangjiang, China." *Journal of Radiation Research,* Vol. 31, pp. 119-136.

R.A. Weinberg, 2008. "The many faces of tumor dormancy." *Acta pathologica, Microbiologica, et Immunologica Scandinavica.* Special Issue: Tumor Dormancy, Vol. 116, pp. 548-551. http://www3.interscience.wiley.com/cgi-bin/fulltext/121415236/PDFSTART.

WNA, 2009. *The Hazards of Using Energy: Some energy-related accidents since 1977.* World Nuclear Association. http://www.world-nuclear.org/info/inf06app.htm.

S. Yi, 1998. "The World's Most Catastrophic Dam Failures. The August 1975 collapse of the Baqiao and Shimantan dams." In: D. Qing, J. Thiboleau, and P.B. Williams (eds.) *The River Dragon Has come! The Three Gorges Dam and the Fate of China's Yangtze River and its People,* 240 pp.

Belarus Repopulating Chernobyl Exclusion Zone

Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

On July 23, Novosti, Interfax, Interia, and other Belarusian, Russian, and Polish news agencies announced that the government of Belarus had decided to resettle hundreds of thousands of people back into the 2,000 ghost-villages in the Chernobyl exclusion zone and other "contaminated areas" from which they had been hastily removed 24 years ago. Assuming 100 persons as the population for one village, the scale of the resettlement might be about 200,000 persons.

That panic-stricken reaction to the 1986 Chernobyl nuclear reactor mishap was a fatal error on the part of Soviet authorities, influenced in part by exaggerated recommendations coming from international radiation protection bodies, such as the International Commission on Radiological Protection and the International Atomic Energy Agency.

A short-term evacuation of people from an area near the Chernobyl power station, for example from the town of Pripyat, situated 3 km from the burning reactor, was a reasonable precautionary measure in the developing crisis. But, as radiation dose rates decreased rapidly by orders of magnitude, there was no sense in keeping the inhabitants of Pripyat away from their homes, where now the radiation level is similar to that in the streets of Warsaw (Jaworowski 2010).

Senseless Relocations

Even more senseless was relocation of people from localities in Belarus, Ukraine, and Russia, far distant from the only really dangerous area, comprising only 0.5 square kilometers, and reaching out to a maximum distance of 1.8 km southwestward from the Chernobyl reactor. But relocation was carried on even after 1986, resulting in the uprooting of 336,000 persons from their homesteads. Now they can come back again.

Ten years ago, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) made clear that these measures were exaggerated (UNSCEAR 2000). Relocations gained nothing in respect to health, as there was no real detectable health hazard. On the other hand, they led to enormous societal losses (ostracism and pauperization of evacuees, exclusion from use of vast "contaminated areas," losses of property and infrastructure), and an epidemic of psychosomatic afflictions among the evacuees (diseases of the digestive and circulatory systems, headache, depression, anxiety, escapism, learned helplessness, unwillingness to cooperate, overdependence, alcohol and drug abuse, and suicides).

The "contaminated areas" were defined as those where fallout of radioactive cesium-137 was above 37 kilobecquerels (kBq) per square meter. In the Soviet Union, this covered more than 140,000 square kilometers of land. But the Chernobyl fallout also reached many other countries. Cesium-137 fallout of more than 185 kBq/square meter was found in Austria. Bulgaria, Finland, Norway, Sweden, Great Britain, Greece, Romania, Switzerland, and Turkey. People in those countries were not relocated.

A cesium-137 level higher than 37 kBq/square meter corresponds to an annual dose of 1.6 millisieverts (mSv), or about a half of the average natural radiation dose in these so-called "contaminated areas."

Normal soil contains about 50 natural radioisotopes biologically much more dangerous than cesium-137. Their total activity in the top 10-cm layer of soil is 400 kBq/square meter (Jaworowski 2002), which is more than 10 times higher than the Soviet "relocation limit." The promoters of the 37 kBq/square meter limit probably did not consider this fact. They also did not take into account that in many countries, where the natural radiation dose rate reaches to as

Petr Pavlicek/IAEA

Some of the thousands of abandoned houses in the Ukraine, Russia, and Belarus, in the wake of the Chernobyl accident. Belarus is now sensibly resettling people in these ghost villages.

much as 100 times greater than the average annual radiation dose received by inhabitants of the so-called "contaminated areas."

In the Soviet "contaminated areas," no increased incidence of neoplastic diseases and genetic disorders was ever registered. Just the opposite: The health of these populations is better than in countries with low natural radiation background. Compared with other noxious agents, ionizing radiation is rather feeble. Nature seems to have provided living organisms with an enormous safety margin for natural levels of ionizing radiation—and also, adventitiously, for man-made radiation from controlled, peacetime sources (Jaworowski 1999).

Minuscule Risks

The current decision of the government of Belarus is an important political event which may bring a positive change in acceptance of nuclear power by the public. It probably results from years of studies reviewed by UNSCEAR, which show that the Chernobyl catastrophe caused a minuscule risk for the general population. The only fatal victims were among the employees of the power station and rescue workers. There is no increase of neoplastic mortality among these workers, nor of cancer incidence and hereditary diseases among the inhabitants of "contaminated areas" (UNSCEAR 2008).

Ultrasound monitoring of the thyroid gland is carried out each year for almost all inhabitants in the so-called "contaminated areas." As a result of such enormous mass screening, up to now a total of about 5,000 thyroid cancers have been detected in children and adults from the "contaminated areas." This corresponds to 0.1 percent of the population living there. Most of these cancers are "occult thyroid cancers," which do not cause clinical symptoms, and have nothing to do with the radioactive iodine-131 dispersed from the Chernobyl reactor. The normal incidence of occult thyroid cancers in the population of Belarus is 9 percent; in the United States, 13 percent; and in Finland, 35 percent.

About 90 percent of thyroid cancers are curable. In many thousands of Swedish and British patients who have received doses of radioactive iodine-131 much higher than the doses absorbed by people in the "contaminated areas," no increase in thyroid cancers was detected, but rather the opposite: a 38 percent deficit of cancers among the Swedish patients, and 17 percent deficit among the British ones.

Calculating by unit of energy produced, the Chernobyl catastrophe caused 0.86 deaths per gigawatt-year of electricity produced, which is 47 times less than for hydroelectric power stations (40 deaths per GWe-year), including 230,000 fatalities caused by the 1975 collapse of the dam on the Banqiao river in China.

Science-Based Recommendations

The government of Belarus took into account the recommendations of a report jointly published in 2002 by four United Nations organizations: the U.N. Development Programme (UNDP), the U.N. International Children's Emergency Fund (UNICEF), the World Health Organization (WHO), and the U.N. Office for Coordination of Human Affairs (UNOCHA). In strong words, the report stated that the enormous effort and billions of dollars spent on mitigation of the effects of Chernobyl accident, did not produce a positive result, but rather aggravated the situation of 7 million people defined as "victims of Chernobyl," and petrified the psychological effects of the catastrophe and of the wrong Soviet decisions.

The report recommended that the three post-Soviet countries and the international organizations abandon the current policy, based on the misguided expectation of mass radiation health effects, which led to the useless expenditure of giant resources. It also presented 35 practical recommendations needed to stop the vicious cycle of Chernobyl frustrations, social degradation, pauperization, and the epidemic of psychosomatic disorders. In practice, the recommendations suggested removal of all the restrictions that had been imposed. Most important among them was that the relocated individuals should be allowed to return to their old settlements.

This last recommendation was fulfilled by the government of Belarus, which should be commended for its courage in standing up to the Chernobyl hysteria, that has been cultivated for years by Greenpeace and other Greens. We come back to normalcy.

Zbigniew Jaworowski is a multidisciplinary scientist who has published more than 300 scientific papers, four books, and scores of popular science articles, including many in 21st Century. *He has been a member of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) since 1973, and served as its chairman from 1980-1982.*

His comprehensive article on Chernobyl and radiation appears in this issue.

References

Z. Jaworowski, 1999. "Radiation risk and ethics." *Physics Today,* Vol. 52: pp. 24-29.

Z. Jaworowski, 2002. "Ionizing radiation in the 20th Century and beyond." *Atomwirtschaft- Atomtechnik,* Vol. 47, pp. 22-27.

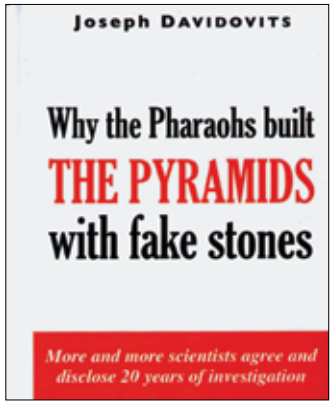
Z. Jaworowski, 2010. "Observations on the Chernobyl disaster and LNT." *Dose-Response*, Vol. 8, pp. 148-171 http://dose-response.metapress.com/media/ h147e148jftulncqvwxydff147/contributions/ 140/143/145/142/03523n6276303212.pdf

UNSCEAR, 2000. "Sources and Effects of Ionizing Radiation." United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000, Report to the General Assembly. Annex J: Exposures and Effects of the Chernobyl Accident, pp. 451-566.

UNSCEAR, 2008. "Health effects due to radiation from the Chernobyl accident" Draft report A/AC.82/R.673, 220 pp. United Nations Scientific Committee on the Effects of Atomic Radiation.

A Chemist Proves that the Pyramids Were Built with Artificial Stone

by Henry Broadbent



Why the Pharaohs Built the Pyramids with Fake Stones
by Joseph Davidovits
(Translated by Claude James from *La Nouvelle Historie des Pyrimides)*
Saint-Quentin, France: Institute Géopolymère, 2009
Hardcover, 288 pp., $24.95
(Available from www.geopolymer.org or booksellers)

This book follows several previous books and publications by French research chemist Joseph Davidovits. I first became aware of his thesis that the Great Pyramids were made of artificial stone, concrete, or something similar, when I read the author's 1988 book—*The Pyramids: An Enigma Solved*—some 15 years ago. But Davidovits's first publication was in 1978. It was the French book *Le livre de la pierre: que le dieu Khnoum protégé Khéops, constructeur de pyramide*.


The Geopolymer Institute

Joseph Davidovits (r.) in a 2002 video demonstrating the making of massive artificial blocks, like those of the pyramid. The ingredients were mixed and molded to form the two kinds of synthetic stone blocks found in the pyramids. The video can be viewed here: www.geopolymer.org/media/pyramid-eng.mp4


The Geopolymer Institute

Since that time, Davidovits has worked and researched to gain acceptance of his thesis against much skeptical opposition and disbelief. He used X-ray techniques, assembled evidence by inspection and photography, located sources of materials, and made samples. He found and translated original hieroglyphical texts and illustrations describing the method used to make the chemically agglomerated stones with which the pyramids, and more, are constructed. Finally, he has published this easy-to-read but amazing book. Davidovits has changed history.

It is staggering to find that the method he describes was developed about 4,700 years ago by the famous Imhotep. The technique enabled Imhotep to build the step pyramid for the Pharaoh Djoser (or Xoser) at Saqqara, across the Nile from Memphis, Egypt. The technique was developed further during the next 200 years to culminate in the construction of the masterpiece of the Great Pyramid ascribed to Khufu (Cheops).

All these pyramids are built from agglomerated stone, and Davidovits sets out the proof decisively in this book. Most of the materials were gathered by quarrying in the area about the pyramids. Later the technique was only used selectively for parts of pyramids because of exhaustion of the mines supplying the minor but essentially critical catalysing chemical compounds.

The book starts by explaining what the

rediscovered science of "geopolymers" is all about. Samples of ancient Egyptian molded "stones" are pictured. They are mostly molded heads (actually sculptures). In particular, see Figure 1, a photo of Vase number 99 in anorthositic gniess, which was exhibited in the French Réunion Musées Nationaux, in 1999. To the question of how such a delicate stone vase could have been chiselled, "the experts have no answer," Davidovits says.

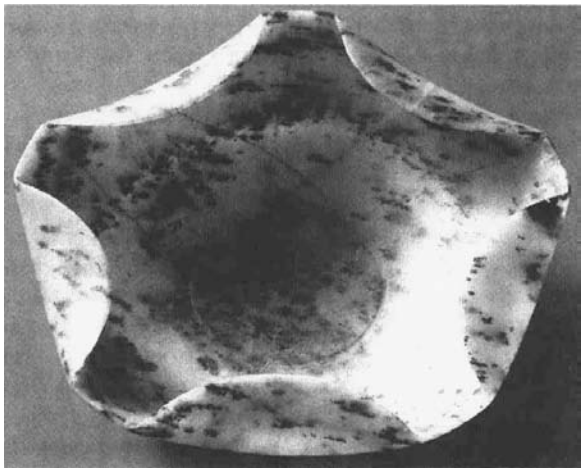


Figure 1
EGYPTIAN VASE CAST FROM ARTIFICIAL STONE
One of the examples of an artifact that is too delicate to have been chiselled from real stone, but had to be cast from a mold of artificial stone. This is part of a 1999 exhibit, "Egyptian Art at the Time of the Pyramids."
Source: *Why the Pharaohs Built the Pyramids with Fake Stones*, Figure 1.2.

How He Got Started

Davidovits tells how his initial research on geopolymers led him to the pyramids of Egypt:

"It was partly chance. My work as a research chemist really started in 1972. For two years, in my first laboratory in Saint-Quentin in Picardie, I worked first of all on the chemical reactions of clay minerals. Nobody took any notice of us and with my team we developed the first applications for the building industry. But in June 1974, I realised that what we were producing were materials that are very close to natural cements, such as rocks based on feldspars, the feldsparoids. One day, as a joke, I asked my scientific partners at the Muséum d'Histoire Naturelle de Paris what would happen if we buried in the ground a piece of the product that we were synthesising in the laboratory at the time and an archaeologist were to discover it in 3,000 years time. Their answer was surprising: the archaeologist would analyse this object disinterred from the garden of a ruin in Saint-Quentin, and the analysis would reveal that the nearest natural outcrop of the stone was in Egypt in the Aswan region!

"It was on that day that I realised that if I did not reveal the synthetic nature of the product we had developed, it would be taken for natural stone."

Davidovits notes that since the stripping of the casing "stones" from the Great Pyramids, the backing blocks are now visible. In his second chapter, he presents photographs of these 500-ton blocks, which show closely fitted, but curved joints (see Figure 2). As an engineer, it is obvious to me that these are not chiselled stone but poured *in situ* concrete blocks.

After treating the various theories of how the pyramids were constructed of hewn stone, Davidovits explains to readers the actual technique, using a cartoon strip drawing of the various steps, indicating the major source of the material and the basic chemistry and process. During 2002, the Geopolymer Institute experimented with the fabrication of five blocks resembling those of the pyramids of Giza, and totalling 12 tons. Recently, researchers at the Massachusetts Institute of Technology experimented with a small-scale pyramid using the same techniques.

Of course, as Davidovits notes, the later Egyptians did make great statues and temples of carved stone. At the beginning of the book there is a map of Egypt showing the "Old Kingdom Pyramids God Khnum Agglomerated stone" in the north, and the "New Kingdom Valley of the Kings

Figure 2
PYRAMID BLOCKS SHOWING CURVED JOINTING
This 1984 photo of 500-ton blocks in the Chephren Pyramid, southeast, shows that the blocks have closely fitted but curved joints. They are not chiselled stone, but blocks that were poured in situ.
Source: *Why the Pharaohs Built the Pyramids with Fake Stones*, Figure A-18.

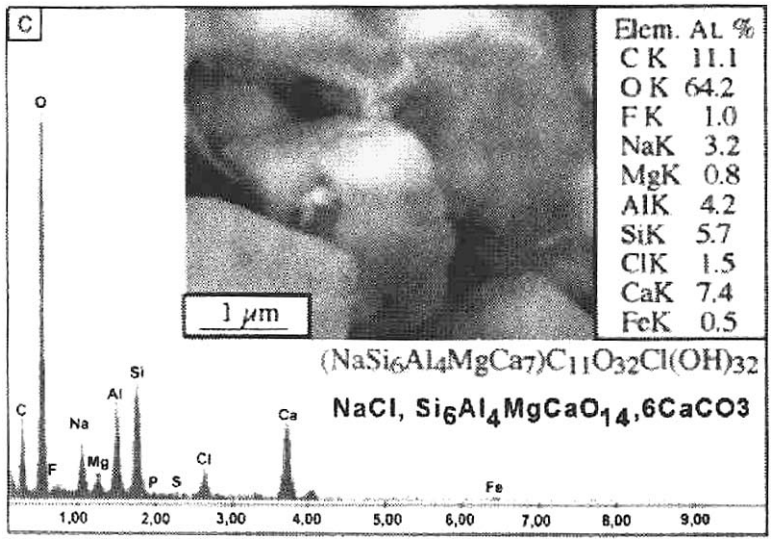


Figure 3
MICROGRAPH OF A CAST BLOCK

This transmission electron micrograph shows micron-sized globules of material glued together. The active ingredients are listed on the right.

Source: *Why the Pharaohs Built the Pyramids with Fake Stones*, Figure 6.1.

God Amun Carved stone" in the south.

However, in the south, after 1,200 years by the presently generally accepted chronology (or 1,800 years by Immanuel Velikovsky's chronology), the collossi of Memnon were made for Pharaoh Amenhotep III by the Royal Scribe Amenhophis. These were made, as described in hieroglyphics on Amenhophis's biographical statue at Karnak, using the technique of agglomeration, "as bread is made using a box [mold]."

Later, the chief sculptor, Tutmosis, produced heads and sculptures by casting "agglomerated stone containing geopolymeric binders," Davidovits says. The Mansoor collection in the Metropolitan Museum of Art in New York City is a collection of Tutmosis's works, or his school, "dating from the period of el-Amarna." These include a head of that incomparable beauty Queen Nefertiti.

Davidovits and his co-researchers are not alone in developing new methods of mimicking the long-lasting properties of natural stone:

- Interest is now being shown in the chemistry of the Chinese cement using sticky rice, which made their defensive walls so enduring.
- The use of synthetic rock, "synrock," for immobilizing radioactive waste is, after 30 years, still being actively researched.
- Climbing-wall shapes are made out of "synrock," acid-etched to give sharp sandstone surfaces, and these "will fool most people, and even some geologists, into thinking it is actual sandstone."

A Resource-Saving Technology

Perhaps the most important aspect for an energy-hungry world is that the geopolymeric stone of the Geopolymer Institute, like that of the "pyramid bricks" of Egypt, saves on resources. If made with an aggregate containing 5 percent to 10 percent of kaolinitic clay, the geopolymeric stone requires perhaps 1/20th of the amount of active cementing material that is presently used in our mass concrete.

Pyramid limestone sample micrographs by Barsoum, Ganguly, and Hug—using transmission electron microscopy—show micron-sized globules glued together with the active ingredients. Such micrographs compared with natural stones definitively prove that the pyramid blocks are cast and not hewn. (See Figure 3.)

Joseph Davidovits concludes the book by dealing with the ill-considered arguments of one of his detractors, and discussing his own problems in getting his work published. The two recent examples he mentions should not surprise readers. Davidovits was refused publication in these so-called scientific journals *Nature* and *Science*.

I cannot do better in summary than to quote Davidovits's final paragraph:

"The German physicist Max Planck wrote: 'In science, one does not convince anybody. The opponents die and the young people, more flexible adopt the new theory.' Thus after more than a quarter of a century of struggle, my theory was officially presented to the public in an exhibition at the French science museum, Palais de la Découverte, in Paris, in 2006-2007. More and more media are now less afraid to pass on the theory."