Letters

Treatment of Radiation Victims in Brazil

A recent article by Leslie Roberts (News & Comment, 20 Nov., p. 1028) discusses the radiation accident in Goiânia, Brazil. This accident, like the nuclear reactor accident at Chernobyl, illustrates the need for international medical and scientific collaboration in these complex settings. I was pleased to join scientists from several countries in this effort. The Armand Hammer Center for Advanced Studies in Nuclear Energy and Health, along with several American and foreign health care companies (Behring, Baxter Health Center, Lilly, Hyland, Lederle, Pfizer, Merck Sharpe & Dohme, Miles Abbott, and others), were able to contribute more than $1 million in equipment and supplies to help Brazilian physicians deal with the accident. Also, this effort allowed these physicians to use a novel therapeutic approach—the drug granulocyte-macrophage colony-stimulating factor (GM-CSF). Details of the efficacy of this therapy will be reported in the biomedical literature.

The *Science* article implies that there is some mystery regarding my role in the accident. Let me clarify this matter. My initial contact was on 2 October 1987, when I received a telephone call from a physician at the National Cancer Institute of Brazil, a facility of the Ministry of Health, regarding possible medical assistance to the victims. I offered my services and the resources of the Armand Hammer Center for Advanced Studies in Nuclear Energy and Health. I was next contacted on 15 October in Bonn, West Germany, by the same individual, who requested that I come to Brazil immediately and, if possible, assist the treating physicians in obtaining GM-CSF. On the same day the Brazilian Consulate in the United States contacted my office to indicate that a visa had been issued to me. I flew immediately from West Germany to Rio, where I began working with physicians at the Naval Hospital at their request and with their agreement.

While in Brazil I agreed to a policy that none of my activities would be discussed with the press; I did not agree to nor could I condone withholding any information from the press outside of Brazil. I also informed the Brazilian authorities that I would report studies involving GM-CSF to the U.S. Food and Drug Administration (FDA) and that specific FDA guidelines might have to be adhered to.

One can judge the alleged query of the Brazilian authorities into my activities by their subsequent actions. I was commended by the Brazilian Navy for my assistance. Furthermore, I have been asked by the state government of Goias and by the Ministry of Health of the federal government of Brazil to organize a meeting of scientific experts to advise the federal government on long-term follow-up of the population of Goiânia and of the immediate radiation victims. This will be held in March 1988. Finally, I have been asked to serve on a Brazilian federal commission investigating emergency response preparedness to nuclear and radiation accidents.

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U.S.–Japan Cooperation

Akira Hasegawa's proposals (Letters, 23 Oct., p. 448) to found an International Science Foundation (ISF) and to initiate it with a U.S.–Japan predecessor are each excellent suggestions. It could, however, be a serious mistake to infer that the latter is a predecessor for the former. Japan and the United States are two of the world's largest trading partners. Cooperative scientific or technological enterprises between them can hardly be divorced from this fact. So let's have a Japan–U.S. Science Foundation, but let's not think of it as an ISF. Incidentally, a formal basis of such an organization may exist in the U.S.–Japan Cooperative Science Program.

A real ISF would require careful consideration of a number of complex factors. For example, what role, if any, would the many existing international cooperative scientific enterprises have? Would the response of these existing institutions be positive? Is there a possibility that the ISF could be organized as a Unesco function? That could after all be appropriate, but in the light of Unesco's recent history, might the ISF be subject to political manipulation? Is the international scientific community sufficiently powerful to prevent this? It is perhaps trite to note, but nevertheless wise to remember, that scientists like everyone else have national loyalties. But it is also true that, as we engage in our favorite enterprises of discussing or doing scientific research together, evidence that we come from different political constituencies usually disappears. So despite, these and other complicating factors, both of Hasegawa's suggestions deserve very serious consideration.

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Space Sample Policy

Glenn H. Reynolds (Letters, 4 Dec., p. 1341) does not make clear the distinction between international agreement on planetary protection and advocacy of quarantining a returned sample from Mars in Earth orbit. I criticized the latter proposal as enormously expensive and lacking either scientific justification or validity. In contrast, international agreements on planetary protection, related primarily to outgoing missions but also to sample return, were discussed by DeVincenzi and Stabekis (*1*). The agreements reflect "the need for containment of any unsterilized sample returned to Earth" (*1*). This need has been related mainly to protection of the sample from terrestrial contamination, and to receiving it in a laboratory on the earth's surface rather than in an orbiting spacecraft. A policy, approved by the executive council of the Committee on Space Research, International Council of Scientific Unions, Paris (COSPAR) (*1*), calls for containment if *not* safe for Earth return and no requirements "if safe for Earth return."

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Antarctic Research

In my contribution to a recent review article on Antarctic research (4 Dec., p. 1361), I did a serious injustice to L. G. Thompson and E. Mosley-Thompson and their associates and predecessors at the Byrd Polar Research Center (BPRC) (formerly the Institute of Polar Studies) of the Ohio State University in not discussing their con-

tributions to the study of microparticles in polar ice cores. Not only has the BPRC group been responsible for most of the advances in that field over the last quarter-century (*1*), but the Thompsons have pointed out more than once in the last decade the dramatic contrast in microparticle deposition rates on the polar ice sheets between Wisconsin and Holocene times (*2*) that was discussed in the article.

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Hot Dry Rock: More Promise Than Problem?

In "Hot dry rock: Problems, promises" (Research News, 27 Nov., p. 1226), Richard A. Kerr portrays the Los Alamos hot dry rock (HDR) program as one that has set its goals too high, has not met these goals, and is recovering from "nearly disastrous damage to their system." As Kerr states, "all went reasonably smoothly" from 1974 until 1979, as Los Alamos completed the world's first HDR system at a depth of 2.75 kilometers (km) in granite rock and successfully operated it for 3 years (*1*). While we sympathize with the British motive for wanting to continue research more conveniently in low temperature rock at shallow depths, efficient and easily usable geothermal energy requires temperatures higher than 200°C. Hence, it was decided that the American program would address the formidable problems of creating and operating fracture systems in deeper, hotter, and more highly compressed rock. Since 1982, we have worked at depths and temperatures of at least 3.6 km and 240°C.

True, we encountered problems with drilling and fracturing the hotter rock. As Kerr states, after reviewing difficulties with our first new well, EE-2 (energy extraction hole 2), a panel of drilling experts provided guidance for the next well; but, of course, their advice could not be applied to the already completed EE-2. Nevertheless, EE-2 served us well for 3 years, until it was damaged during a 1983 hydraulic fracturing experiment as a consequence of a piping flange failure. The well was repaired temporarily and was used for three more years. Although this is hardly "disastrous damage," the well was limited in production rate, which accounts, in part, for our inability to achieve the goal—35 megawatts of thermal power—during preliminary reservoir testing in 1986. From September through November of 1987, the well was permanently repaired by drilling out its side, in an operation called "sidetracking." Then the bottom was redrilled for 1 km about 25 meters away from the old well, bypassing its damaged zone. This drilling was trouble-free and, although conducted in the deepest and hottest zones, was accomplished at rates 2½ times faster than in the case of the original drilling. When combined with recent successful drilling in the other well, EE-3, this indicates that the problems of the late 1970s and early 1980s are behind us.

Fracturing of deep hot rock also has proved to be a major obstacle to HDR development. However, the problem is yielding to research. In early years, the mapping of hydraulic fractures with the locations of induced microearthquakes was in its infancy—so much so that we placed more confidence in our theoretical predictions of fracture patterns than in the mapping and drilled accordingly. Consequently, when tectonic stresses and natural joint patterns unexpectedly changed with depth, the predrilled wells could not be linked with fractures. Thanks to efforts at Los Alamos and in the British HDR program, seismic fracture mapping has been remarkably improved, and fractures can be located with a precision of 20 meters (*2*). HDR reservoirs are now created by drilling the injection well completely and the production well partially, and then by fracturing the injection well and mapping the fractures with seismometers at the bottom of the partial well and nearby shallow wells. The partial well is then finished by drilling through the fractures. This technique worked superbly during two recent redrilling campaigns at Los Alamos and during the most recent drilling in England.

In summary, thanks to improvements in drilling and fracturing, HDR development is poised to take great strides. A partnership of the Bechtel Corporation and Intermountain Geothermal (a subsidiary of Chevron) is exploring the feasibility of developing an HDR reservoir at Roosevelt Hot Springs in Utah. In the meantime, we continue technical collaboration with our Japanese colleagues, who are developing a reservoir at Hijiori, and with the British, whose next endeavor is to create a reservoir at a depth of 4.5 km.

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Satellite Map

I could hardly agree more with the comments (News & Comment, 4 Dec., p. 1346) of Representative George Brown (D–CA) on the need for complete freedom of access to information (less truly classified material). However, the remark that "a map sold to tourists by the National Air and Space Museum giving the name, orbit, and launch date of all the satellites in space, information that is considered 'higher than top secret' " needs clarification. Indeed, there is such a graphic display chart, "The Satellite Sky," on sale at the Air and Space Museum; but it is not even remotely classified. Nor, in fact, have any of the data on the graph been abstracted from any limited access documents. I should know; I am the author of that graph. All of the information displayed is readily available in the open literature, and most of it comes from *Pravda, Izvestia*, or *Krasnaya Zvezda*. It seems the Soviet Union, pleased with its successes in space, quite freely makes available the orbital parameters and launch date of its Earth-orbiting spacecraft. Determining the launch base is not a complicated exercise in spherical geometry. On the other hand the Pentagon chooses not to make this information available to the public for many months after any given launching, as though that procedure would hide their spacecraft from any country that decided it wanted that knowledge. Brown is correct, of course, when he states that our country's efforts to control access to information is far overdone and is a practice that should be halted.

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