Letters

Radioactivity in the Urals

In the article "Are portions of the Urals really contaminated?"* by Stratton *et al.* (26 Oct. 1979, p. 423), a plausible argument is made that careless and imprudent weapons testing at the Novaya Zemlya testing facility in the Soviet Union could have resulted in local hot spots in an area of the southern Urals near Chelyabinsk. This article, whose authors are, or have been, scientists at the Los Alamos Scientific Laboratory, appears to be a response to a number of seminars, articles, and publications of Zhores Medvedev (*1*). Medvedev's discussions center on the nature and extent of an unusual incident that may have resulted in the contamination of an area on the order of hundreds of square miles with millions or tens of millions of curies of strontium-90, cesium-137, and smaller quantities of other isotopes from fission reactions.

In the absence of more detailed information about the incident at Chelyabinsk, and in spite of the lack of more relevant weather data in the article, the mechanism they suggest must be considered a plausible, although unlikely, candidate for explaining a possibly contaminated region in the Urals. Curiously, however, the authors find it difficult to understand how an incident of this magnitude has not been more extensively discussed in the West. I do not (*2*).

In the middle and late 1950's, the United States conducted atmospheric tests of high-yield thermonuclear devices at the Nevada testing range. During this period of testing, extensive fallout occurred in continental areas of the United States, although prudent precautionary measures were used to avoid exposing more densely populated areas. The health effects of this weapons testing program, conducted in part by the Los Alamos Scientific Laboratory, had not been discussed extensively in the West until recent interest was generated by the news media and by Senator Edward F. Kennedy's hearings on the matter (*3*).

The various investigations revealed that fallout readings had been classified, officials of the Atomic Energy Commission had misinformed local groups about the health effects of the fallout, and pressure had been brought on research groups at the National Institutes of Health to suppress results indicating the presence of adverse health effects in the exposed populations.

So effective was the suppression of scientific findings that the results of these activities went more or less unnoticed. Since the Los Alamos Scientific Laboratory was involved in this testing program, it is hard to understand how Stratton *et al.* could so strongly state a disbelief that such an incident could go unnoticed in the West.

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References

1. Z. A. Medvedev, *New Sci.* (4 November 1976), p. 264; *ibid.* (30 June 1977), p. 761; *ibid.* (10 November 1977), p. 352; *Soviet Science* (Norton, New York, 1978); *Nuclear Disaster in the Urals* (Norton, New York, 1979).
2. T. A. Postol, *Science* **206**, 326 (1979).
3. Chicago *Tribune* (1-5 April 1979); the collected articles are available in booklet form from the Chicago *Tribune*.

The article by Stratton *et al.* argues that fallout from weapons tests provides a plausible explanation of the radioactive contamination reported by Medvedev (*1*) to have occurred in 1957 or 1958 in the region of Kyshtym. Another possible explanation is an autocatalytic fission reaction that might have occurred underground if plutonium-containing wastes from a chemical separation plant had been carelessly discarded. The autocatalysis arises because the isotope plutonium-239 has a strong fission resonance at an energy of 0.3 volt (*2*). If an underground solution of plutonium once became critical, the reactivity would increase rapidly as the temperature rose. The whole mass might become strongly supercritical at a temperature of about 2000°C, causing an explosion that would spread over the surrounding countryside the long-lived fission products which had accumulated in the ground together with the plutonium. Detailed kinetic calculations would be necessary to determine the conditions under which such an accident could happen. Whether it actually did happen at Kyshtym, only the responsible Soviet authorities can tell us.

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References

1. Z. A. Medvedev, *Nuclear Disaster in the Urals* (Norton, New York, 1979).
2. S. F. Mughabghab and D. I. Garber, *Neutron Cross Sections*, vol. 1, *Resonance Parameters* (Report BNL 325, Brookhaven National Laboratory, Upton, N.Y., ed. 3, 1973), p. 94-3.

Stratton *et al.* hypothesize that evidence of radioactive contamination of an area east of Kyshtym is better accounted for by postulating localized fallout (perhaps with precipitation) from explosion of a nuclear weapon in the Novaya Zemlya area in late 1957 or early 1958 than by a major reactor incident or by explosion of radioactive waste material stored or buried near Kyshtym. The case for radioactive fallout is weakened, however, by the authors' use of a height contour chart of the 500-millibar pressure surface over North America on 6 December 1976 to illustrate an atmospheric circulation pattern of the type that, if present in the appropriate geographical location, could have carried radioactive clouds from Novaya Zemlya to the vicinity of Kyshtym. A sample 72-hour trajectory, presumably also at the 500-millibar level, is shown in the article, but was also over North America in 1976.

The authors' thesis may be sound, but one wonders why they did not make use of the published series of daily 500-millibar Northern Hemisphere charts (*1*) that goes back to and beyond the period in question? I have done so, and I quickly discovered that no flow patterns of the type required occurred in December 1957. Furthermore, such flow patterns appeared on only one occasion in January 1958, and on one in February of that year.

The first possible period found was 28 to 31 January 1958, and the estimated 96-hour trajectory was a rather indirect one, looping cyclonically to the west and south of Kyshtym before arriving in the alleged fallout area. This trajectory did appear to have been associated with precipitation (snow), which would help account for the localized fallout in the Kyshtym area.

In the second possible period, 10 to 11 February 1958, the more than 48-hour trajectory is a rather direct one from Novaya Zemlya. Furthermore, the air is moving southward to the west of an upper-air

*A longer and more technical comment on this subject by J. R. Trabalka *et al.* will appear as an article in a subsequent issue.

trough where sinking air is generally found.

Hence, the suggested hypothesis is tenable only if the airburst occurred on either 28 January or 10 February 1958. Or—to turn the argument around—how about accepting the cause-hypothesis and concluding that the weather maps for the Soviet Union pinpoint the times of the nuclear tests?

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References

1. U.S. Weather Bureau, *Northern Hemisphere, Sea Level and 500-Millibar Charts* (Department of Commerce, Washington, D.C., January 1949 on).

We find some of Postol's allegations disturbing, incorrect in a number of places, and not relevant to our article. Corrections and comments are in order.

High-yield thermonuclear devices were never exploded in Nevada. Such experiments were conducted only in the Pacific test range.

Information on fallout from U.S. nuclear weapons tests has been well documented for many years and is readily available to those wanting it, particularly to those residing in the vicinity of the Nevada Test Site. Information on fallout from all U.S. nuclear weapons tests was published in the semiannual reports of the Atomic Energy Commission (AEC), beginning with Trinity (*1*), the first nuclear weapons test conducted in July 1945. In addition, two extensive hearings (*2*) were held by subcommittees of the Joint Atomic Energy Committee (27 May to 3 June 1957 and 5 to 8 May 1958). These contain tables of the exposures to the off-site population and, in some cases, the measured fallout patterns. In particular, the 16th report (*3*, pp. 48–52) of the AEC gives the exposures to populations from operation Upshot-Knothole in 1953, which contributed the major exposure to the population of southwest Utah.

Before a test series at the Nevada site, senior members of the test organization visited the surrounding communities to inform them of the program, outline the protection measures being taken, and to answer questions. Movies of previous nuclear tests were shown, and information pamphlets were distributed (numbering into the thousands) giving details of the purpose of the program, precautions being taken, and exposures sustained by off-site populations.

Radiation monitors from the Public Health Service were assigned to a community, held discussion sessions, and lived and worked in the community. Resident monitors were augmented by roving monitors in radio contact with the test organization. In addition, the state health officers in Nevada, Utah, California, and Arizona were kept advised.

The phenomenology of fallout was described in 1950 (*4*) and in updated editions (*5*) of the same publication. These have been available from the Governmental Printing Office for a nominal fee.

With reference to Postol's final sentence, we can only paraphrase Medvedev's allegations: Hundreds killed, tens of thousands injured, more than 1000 miles seriously contaminated and closed to the public. We repeat that we find it hard to believe that such a calamity could occur and the event not be discussed in detail by more than one individual in 20 years.

Dyson raises an interesting and valid point. The thermal fission cross section of plutonium-239, indeed, displays a resonance at 0.3 volt, the value of which, at the peak of the resonance, is about three times the cross section at 0.025 volt. This resonance is sufficiently large that the fission and absorption cross sections are influenced by it even at thermal energies (0.025 volt). The usual relation between cross section and energy (E) is that the cross section decreases inversely as the neutron velocity (v) increases; the resonance changes this relation so that the cross sections decrease less rapidly with increasing E or v, and, for a very highly moderated fissioning system, the resonance produces a positive temperature coefficient of reactivity, albeit small at low temperatures.

This effect is explained as follows. The neutron multiplication factor of (for example) a plutonium-239–water system can be written

$$k_\infty = \frac{\nu\Sigma_f(\mathrm{Pu})/\Sigma_a(\mathrm{Pu})}{1 + \Sigma_a\,(\mathrm{H_2O})/\Sigma_a\,(\mathrm{Pu})}$$

in which ν = neutrons per fission, the Σ are macroscopic cross sections, and f and a refer to fissions and absorptions. Thus, if the ratio $\Sigma_a(H_2O)/\Sigma_a(Pu)$ is both large and decreasing faster with increasing temperature than the ratio $\Sigma_f(Pu)/\Sigma_a(Pu)$, the reproduction number will increase with temperature—a positive coefficient. The dominance of the denominator, however, implies very high moderation; the first significant effect of the fissioning of such a sluggish system will be to boil water, both expanding the system and reducing moderation. Reactivity

would then decrease rather than increase.

We agree that a study with a rigorously correct computer program (these are called coupled neutronic-dynamic-thermodynamic codes) is necessary to establish this qualitative discussion in a quantitative manner and should be done to settle the question. We reassert, however, that widespread dispersal of fission products by such a mechanism is monumentally difficult and a most unlikely mechanism to cause them to be airborne, especially over 1000 square miles.

We thank McClain for advising us that 500-millibar charts for the entire Northern Hemisphere are available, especially for the period from 1957 to 1958.

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References

1. *13th Semiannual Report of the Atomic Energy Commission* (Government Printing Office, Washington, D.C., 1953), p. 80.
2. Special Subcommittee on Radiation, Joint Committee on Atomic Energy, *Fallout from Nuclear Weapons Tests* (Government Printing Office, Washington, D.C., 1959); *On the Nature of Radioactive Fallout and Its Effect on Man* (Government Printing Office, Washington, D.C., 1957).
3. *16th Semiannual Report of the Atomic Energy Commission* (Government Printing Office, Washington, D.C., 1964).
4. S. Glasstone, *Effects of Atomic Weapons* (Department of Defense and Atomic Energy Commission, Washington, D.C., 1950).
5. _____, *Effects of Nuclear Weapons* (Department of Defense and Atomic Energy Commission, Washington, D.C., 1957); *ibid.* (1962); *ibid.* (1964); *ibid.* (1979).

Significant Sevens

In his recent article on Oral Roberts "And God said to Oral: Build a hospital" (News and Comment, 18 Apr., p. 267), William J. Broad observes that secular forces in the form of the 1974 National Health Planning and Resource Development Act (NHPRDA) forced Roberts to reduce the number of beds in his City of Faith "Health Care and Research Center" from 777 to 294. Due to the biblical significance of the number seven, Roberts went so far as to liken the NHPRDA to the Devil. However, both Broad and Roberts seem to have missed God's Divine Order as expressed through the NHPRDA.

Mirabile dictu, 294 is equal to $7 \cdot 7 \cdot 7 - 7 \cdot 7$. Thus, Roberts may wish to note that the new 294-bed City of Faith is actually "two sevens better" than the original Divine Plan.

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