Nuclear detective story

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Nuclear Disaster in the Urals. By Zhores A. Medvedev. Pp.214. (W..W. Norton: New York; Angus and Robertson: London, 1979.) $12.95; £5.95.

DR MEDVEDEV has spent much time in studying widespread but indirect information about a very serious nuclear accident which occurred in the Urals, seemingly around 1957. His book begins with an extensive account of the hard and ingenious detective work which was needed to extract information from seemingly irrelevant papers on radioecology published in Russia, often years after the event. He gives an impressive picture both of the all-pervasive thoroughness of the censorship and at the same time of the number of points which nevertheless slipped through, and from which he has built up a convincing picture of serious contamination over a large area on the eastern side of the southern Urals where the original Soviet military nuclear industry was situated.

Dr Medvedev seems unnecessarily anxious to establish his excellent case for the reality of the disaster, and his arguments are not always individually convincing. For example, he says that papers written during the following few years on the radioecology of the region purported to describe the take-up of radioactive material, especially ^{90}Sr (strontium-90), by plants and animals and the food chains connecting these. To do this properly, he claims that less than 10% of the animals concerned could have been trapped or shot without disturbing the ecology which it was desired to investigate. This is hardly relevant, at least in the short term, for deer which are at the end of a chain (assuming that human hunters are not to be sampled). Using this figure of 10%, he deduces that the area contaminated must have been at least ten times the area found by dividing the number of deer shot, by the average population density. It could however, have been intended to shoot 100% of the larger contaminated ungulates, to prevent them from migrating to regions where they might later be shot and eaten. In this case one would deduce a maximum area ten-times-smaller than Medvedev does.

The book has clearly been written rather hurriedly, leading to some errors. For example, on page 173, he states that ß-particles can penetrate 2 — 8 cm into living tissue and he (or the translator) has missed a misprint of protons for photons. More seriously, on page 74, he defines the permissible dose of radiation as being the amount that is assumed not to cause harmful effects, and on page 21 says that the next generation will suffer severely if they are born from parents with ^{90}Sr in their bones. This and its daughter product ^{90}Y (yttrium-90) are both pure β-emitters with a range of only a few millimetres in tissue.

In spite of these minor errors, I accept without reservation that a major accident must have happened around 1957 which contaminated probably tens and conceivably hundreds of square kilometres — to a level of 1000-4000 Ci/km^2. For the reason given above, I do not accept the numerical estimate of 400 square kilometres of heavy contamination, but there seems no doubt that Dr Medvedev is right in describing the event as a major disaster, and that this was connected, like our Windscale reactor fire, with the military production of plutonium for bombs.

The final sixth of the book is speculative. The censorship has successfully hidden the cause of contamination. The US intelligence services may know the truth, but the thoroughly "sanitised" documents extracted from the CIA do not divulge it. Accordingly Dr Medvedev has had to rely on hearsay. Early guesses by local but uninformed people included an accidental bomb explosion and an escape of material from a runaway reactor. A third guess is that the wastes left after extraction of plutonium and unsatisfactorily stored, exploded. At first sight either of the first two seems possible and the third seems impossible on thermodynamic grounds, for the same reason that you cannot make a good fire with the ashes of an earlier one. Nevertheles, this is the theory that Medvedev espouses, and as his arguments are plausible they need to be examined.

The major positive argument is the size of the area affected. In each square kilometre the ^{90}Sr observed was of the order of that produced by the fission of a kilogram of uranium or plutonium. By 1957 the accumulated wastes could have sufficed to cover 400 km^2 if an adequate distribution mechanism existed. So could a 'dirty' H-bomb, with no distribution problem; but a fire in a runaway reactor could hardly do so. The actual area covered by heavy contamination is therefore important.

The second argument is the low ratio of ^{137}Cs to ^{90}Sr which varied from 1:8 (in a lake) to 1:1000 in soil, instead of the roughly 1:1 expected from fission. Dr Medvedev suggests that most of the ^{137}Cs had been removed from the wastes for industrial or medical use. The large difference between lake and surface soil, however, looks much more like the result of leaching away of the mobile caesium in the soil leaving the less mobile strontium near the surface.

The chief argument against the waste-explosion theory is the impossibility of producing an explosion which would pulverise the (non-volatile) material to the 1—10 μm sized particles needed to spread it over hundreds of square kilometres. Such an explosion would have to be of the same order as the Bikini H-bomb test and is not consistent with the type of steam explosion that could arise due to water running into radioactively heated waste. This could throw a lot of material for hundreds of metres but could not produce the fine pulverisation of the whole mass of material needed for its uniform distribution.

Dr Medvedev's alternative source of energy lies in the plutonium with which the wastes are invariably contaminated. At the Hanford works in Richland, Washington (one of the largest atomic plants in the US) some 100 kg of plutonium was concentrated over a decade, by a process equivalent to chromatography, in the topmost layer of mud in the trenches into which liquid wastes were run. This process might indeed eventually produce a critical concentration and this could support a chain reaction. This would, however, necessarily start slowly with a "delayed-critical" concentration in wet material, as the plutonium could not be chromatographically concentrated in the dry. This reaction would probably raise the temperature and reduce reactivity to equilibrium values at which plutonium was burnt as fast as it was added. At most it could raise the temperature only so fast (the delayed doubling time being several seconds) as again to produce a steam explosion. It is difficult to see how this could reach the effect of even a ton of TNT and quite impossible to see how it could reach the megaton scale required to contaminate hundreds of square kilometres.

Although the visible flash lighting up the sky reported by the CIA in 1955 (page 195) is consistent with an accidental H-bomb explosion, I do not think this the only possible explanation of the facts. I am unconvinced by Dr Medvedev's ecological arguments that the area involved was 400 km^2, and a very respectable smaller area could have been contaminated to the level observed by an uncontrolled reactor fire in which a large part of the uranium fuel was burnt and dispersed with the smoke of burning carbon moderator. Dr Medvedev realises himself that there are difficulties with any of the mechanisms proposed for a waste explosion. In his own words (page 163), "Truly, scientific imagination (or a capacity for 'science fiction' if you will) is needed to construct hypotheses about the exact causes of the explosion". I can only agree. But I hope a lot of people will read the book and see whether they agree too. (I congratulate the translator.) □

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