Iodine-131 Fallout from Underground Tests II

In a recent report (*1*), List, Telegadas, and Ferber take issue with my earlier conclusion (*2*) that vented underground tests in Nevada were the probable sources for the repeated occurrences of iodine-131 fallout in midwestern United States during May 1962. In doing so they provide no evidence to establish that the underground shots in question were contained, but they suggest that precipitation scavenging of a stratospheric source of debris by thunderstorms which penetrate into the stratosphere explains this fallout. Neither adequate observational evidence nor a sound theoretical basis is provided by List and his co-authors in support of this proposed fallout mechanism. The purpose of this report is to indicate clearly that the Nevada source cannot be discounted in favor of the stratospheric source.

The direct way to establish that a given underground shot was not a source of fallout is to present the evidence for its containment. For the three May 1962 underground shots in question, List *et al.* admit that containment failed for the 19 May shot, that the amount of radiation was above the background for the detonation point for the 12 May shot, and that some radioactive debris escaped through drill holes within 24 hours following the 7 May shot. In the absence of reliable information about the amounts of radioactivity which escaped in each case, none of these underground shots can be disregarded in any objective evaluation of the subsequent downwind fallout (*2*).

Another possibility for assessing the origin of the May 1962 fallout is provided by the U.S. Public Health Service gamma-ray spectra for highly radioactive rain samples collected in Kansas and Missouri during May 1962 and measured within several weeks thereafter. If these gamma-ray data allow estimation of the iodine-131 content of the rainwater samples (*1*, table 3) they also should show whether the fallout is essentially unfractionated debris derived from atmospheric shots or highly fractionated debris from underground shots. I am advised (*3*) that the U.S. Public Health service will release these gamma-ray spectra in the near future.

List, Telegadas, and Ferber adopt the suggestion of Machta (*4*) that the May 1962 iodine-131 fallout resulted from the scavenging of stratospheric debris at 50,000 feet by severe thunderstorms. There are numerous difficulties with this explanation, some of which I have already pointed out (*2*). The coincidence of the convective cloud top with the stratospheric debris source is not adequately established for even one of the several fallout occurrences during May 1962. The heights of convective cloud tops based on radar echo data are often seriously overestimated, as Jordan has shown (*5*). It is also not clear that stratospheric air is appreciably incorporated into such convective systems. Furthermore, scavenging by precipitation takes place at lower elevations and is hardly a quantitative process. In any case, precipitation scavenging of a stratospheric source is not sufficiently well-established in these instances to rule out alternative sources for the fallout.

The schedule of Nevada underground tests and the paths for Nevada debris clouds in the lower atmosphere coincide with the timing and location of the repeated instances of iodine-131 fallout in the Midwest during May 1962 (*2*). The deposition of debris from tropospheric clouds near the western edge of the convective storm-system can account for the observed (*6*) localization of the fallout. Finally, the selective release of iodine-131 and a few other volatile and gaseous products from vented underground tests (*2, 7*) provides a plausible explanation for the occurrence of high concentrations of iodine-131 in milk unaccompanied by large increases in the radioactive particle concentration of surface air (*6*).

In discussing fig. 5, List *et al.* maintain that periods of high concentrations of iodine-131 in milk are associated mainly with periods of atmospheric testing, and thus that in most instances the iodine-131 fallout is due to atmospheric tests. However, it should be pointed out that not only are the main peaks of June and July 1962 due to Nevada tests (*8, 9*), but the sources for the high peaks in September 1961 and May 1962 are unsettled (*2, 10*) and may also be due mainly to Nevada tests. Since iodine-131 fallout attains appreciable concentrations in milk only when dairy animals are in pasture, the observed distribution of high concentrations of iodine-131 in milk is easily reconcilable on the basis that the fallout is mainly due to Nevada tests.

The discussion of the fallout situation during March and April 1962 by List *et al.* is somewhat confusing. During this period, late in the interval between atmospheric test series, Nevada tests included one cratering test on 5 March plus 11 underground tests, of which three were admittedly not contained (on 1 March, 8 March, and 14 April). In this period, the U.S. Public Health Service Pasteurized Milk Network, for which pooled samples are used, showed detectable amounts of iodine-131 in 10 percent of all samples, 38 showing 10 to 25 pc/liter and 11 showing 25 to 45 pc/liter. All but four of the 49 milk samples which showed detectable amounts of iodine-131 during March and April 1962, occurred in areas north of 37°N, where dairy animals do not feed appreciably on fresh pastures until sometime in April or even May. Most of the samples showing detectable iodine-131 were collected in March. Therefore, the absence of observed high concentrations of iodine-131 in milk following the three vented shots of early March is at least partly explained by the occurrence of the fallout in areas where there was little or no grazing at the time. In cattle and sheep slaughtered in Kentucky and Tennessee on 23 April 1962, prior to the resumption of atmospheric tests, the iodine-131 content of the thyroids was 10 to 100 times the minimum detectable amounts (*11*). The vented underground shot of 14 April would thus seem to be the likely candidate as the source of this fallout.

List *et al.* state: "In 1963, all milk samples collected in the United States after the middle of the year had I^{131} concentrations below 10 pc/liter despite the continuation of underground tests." However, it should be noted that since early 1963 the U.S. Public Health Service has reported only monthly averages of iodine-131 concentrations for each milk sampling location, not data for individual milk samples, and the method of averaging serves to obscure appreciable amounts of iodine-131 for individual samples, especially in October 1963 and thereafter. It is reported (*12*), "Beginning with the October 1963 data, iodine-131 values of 10 pc/liter (the minimum detectable concentration) are considered to be zero for averaging purposes; previously 5 pc/liter was used in calculating the average." By this procedure, monthly averages for all stations have been routinely reported as less than 10 pc/liter, and thus would seem to be below the limit of detectability and are therefore taken to be zero. For example, this averaging method would serve to conceal up to 100 pc/liter for 10 percent of the samples at each station, or the equivalent. Also, in view of the averaging involved in the "pooling" of samples in the sparse U.S. Public Health Service Pasteurized Milk Network, individual dairies can experience iodine-131 concentrations more than an order of magnitude higher, as Pendleton, Lloyd, and Mays (*13*) have shown. Thus, any iodine-131 fallout in the continental United States during 1963 is obscured by the inadequacies of the monitoring network, compounded by the method of averaging and reporting the data.

Figure 4 in the report of List *et al.* indicates a hypothetical path for the 19 May 1962 vented debris cloud, not the actual track for the airborne radioactivity based on cloud tracking by aircraft or on other direct observations. It is well known that the computed trajectory of a radioactive cloud is very sensitive to assumptions about the height of the cloud, the mesoscale behavior of air flowing over mountains, or vertical motions due to large scale systems. Therefore, the absence of fallout anywhere along the early part of the assumed trajectory is poor evidence against the Nevada-shot origin for the subsequent fallout in Kansas and Missouri. Elsewhere, List *et al.* contend that the presence of iodine-131 in precipitation from thunderstorms in the midwest supports their suggested mechanism of stratospheric scavenging. Because tropospheric sources are also in the vicinity (*2*), their suggestion remains merely a possibility. Again in table 4 (*1*), also following Machta (*4*), Nevada tests are omitted as a probable source of the large amounts of iodine-131 fallout in September 1961 and again in May 1962. The origin of the fallout in both instances is unsettled, and any objective statement would seem to require inclusion of vented Nevada underground tests as possible sources. In this connection it is noted that there is consistent radiochemical and meteorological evidence that the vented Nevada underground shot of 15 September 1961 contributed to the 18–22 September fallout in southeastern United States (*10, 14*).

In conclusion, it can be said that the proposal that the occurrences of iodine-131 fallout during May 1962 were due to precipitation scavenging of stratospheric sources of debris by severe convective storms is an interesting suggestion, but unequivocal observational evidence and adequate discussion of the specific mechanisms involved have still to be presented. So far, there have been no reported instances of heavy fallout resulting from rains, in which the direct tapping of a stratospheric debris source would clearly be involved. A recent study (*15*) of two convective storms in Oklahoma during May 1963 indicated no incorporation of stratospheric radioactivity for penetrations to heights of about 55,000 and 60,000 feet.

Despite some official criticism (*16*) of my earlier report (*2*), my conclusions about the possible underground test origin of the May 1962 fallout remain valid. The occurrence of large amounts of iodine-131 fallout from underground tests was unmistakably illustrated by fallout in northwestern United States from the vented underground shot of 13 June 1962 (*8*) and in Utah during July 1962, due to several Nevada cratering shots (*9, 13*). Furthermore, my contention (*2*) that underground tests may be difficult to contain seems well confirmed by recent events. Since the signing of the partial test-ban treaty, the U.S. Atomic Energy Commission has reported two accidental ventings of underground nuclear explosions in Nevada: the Eagle event of 12 December 1963 and the Pike event of 13 March 1964 (*17*). List, Telegadas, and Ferber indicate (*1*, fig. 5) that additional ventings occurred during the last quarter of 1963. More recently, atmospheric radioactivity detected over the Northern Pacific Ocean was attributed to the large Soviet underground test of 15 January 1965, at Semipalatinsk in central Asia.

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References and Notes

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