SCIENCE & GLOBAL SECURITY
2018, VOL. 26, NO. 1

Online supplement

The 22 September 1979 Vela Incident: Radionuclide and Hydroacoustic Evidence for a Nuclear Explosion

Appendices A, B, and C

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Introduction

Appendices A, B and C accompany the 2017 article, “The 22 September 1979 Vela Incident: Radionuclide and Hydroacoustic Evidence for a Nuclear Explosion, ”The 22 September Vela Incident,” published in *Science & Global Security*.[1]

The article offers a new analysis of radionuclide and hydroacoustic data to support a low-yield nuclear weapon test as a plausible explanation for the still contentious 22 September 1979 Vela Incident, in which U.S. satellite Vela 6911 detected an optical signal characteristic of an atmospheric nuclear explosion over the Southern Indian or Atlantic Ocean. Based on documents not previously widely available, as well as recently declassified papers and letters, this article concludes that iodine-131 found in the thyroids of some Australian sheep would be consistent with them having grazed in the path of a potential radioactive fallout plume from a 22 September low-yield nuclear test in the Southern Indian Ocean. Further, several declassified letters and reports which describe aspects of still classified hydroacoustic reports and data favor the test scenario. The radionuclide and hydroacoustic data taken together with the analysis of the double-flash optical signal picked up by Vela 6911 that was described in a companion 2017 article, “The 22 September 1979 Vela Incident: The Detected Double-Flash,” can be traced back to sources with similar spatial and temporal origins and serve as a strong indicator for a nuclear explosion.[2]

Appendix A: A search for alternative sources of the 1979 October/November iodine-131 detections

The presence of iodine-131 in southeast Australian sheep thyroids from October-November 1979 has been demonstrated. Likewise, a meteorological analysis has shown a connection between southeast Australia and the site of the suspected clandestine low-yield nuclear test near Marion Island on 22 September 1979.

The detected concentration of iodine-131 at the low concentration of 1.9 ± 0.6 pCi/g makes it necessary to identify other potential sources of iodine-131 in VanMiddlesworth's Australian thyroid surveillance. The presence of iodine-131 would be traceable to nuclear fission from a nuclear explosion or a civilian facility producing or using iodine-131, or the presence of iodine-131 in the waste treatment cycle (all sourced from a nuclear reactor).

Before the 1979 October/November detection, it was highly unusual, but not unprecedented, for low levels of iodine-131 unrelated to the French, U.S. or U.K. Pacific atmospheric nuclear tests to be detected in Australian sheep thyroids.[3] Between 1966 and 1972, 4,692 sheep thyroids from the Melbourne abattoir were tested, (approximately 470 samples). Iodine-131 levels between 0.5–1.5 pCi/g were detected in six cases.[4] Similarly, among hundreds of samples between 1958 and 1965, only about 16 had an iodine-131 activity in concentrations in the same range.[5] More than half of the combined total of 22 cases occurred within one to two months of a Chinese atmospheric nuclear test in the northern hemisphere, France (in Algeria), or the Soviet Union. In some cases, a connection was suggested between these northern hemisphere tests and Australian and/or New Zealand livestock iodine-131 detections. Currently available information suggests this is unlikely given the relatively low yield of some of the tests, consequent weak injection into the troposphere of fission products, and/or an expected delay from stratospheric injections. In a few cases the detections were dismissed as erroneous. While uncertainty remains, it is likely that these detections were not confirmed through spectroscopy, but instead relied solely on the single channel pulse height analyzer (SCA) counting technique within the energy bin of 0.3–0.4 MeV.[6] There is also a risk that the detections were due to Pb-214, with its 351.9 keV line that had leaked into the detector cavity in the form of its radon-222 precursor.

In summary, out of several thousand thyroid glands from southeast Australian sheep tested up to 1972, the 1979 October/November detections of pCi levels of iodine-131 are the only ones, outside of known atmospheric nuclear tests in the southern hemisphere, that can be associated with an extraordinary event. VanMiddlesworth's available annual reports show that this includes 1973 through February 1974, and April 1979 through May 1980.

Iodine-131 emission from the civil nuclear fuel cycle.

The closest operating nuclear reactor in Australia in 1979 was the High Flux Australian Reactor (HIFAR) facility at Lucas Heights near Sydney. In the third and fourth quarters of 1979, approximately 3.52 GBq (0.095 Ci) of iodine-131 was released into the air from various radiochemical buildings.[7] Precise dates are not provided, nor whether they were many small or a few large releases, therefore there is insufficient data to inform atmospheric transport modeling. But, Further, the amount of iodine-131 released over six months is equivalent to one radiotherapy treatment for hyperthyroidism or thyroid cancer.[8]

Also, iodine-131 was not detected in milk at levels less than 1 mBq/g (0.027 pCi/g) in the vicinity of the reactor in 1979.[9] While sheep thyroids concentrate iodine more than 10,000 times more efficiently than cow's milk,[10] the proximity of the sampled cows to the release point(s) at a distance of only a few kilometers, suggests that spatial dispersion of potential releases over an area of tens or even hundreds of thousands of square kilometers would render iodine-131 undetectable in the thyroids of grazing animals. Further, sheep near Lucas Heights would not be slaughtered at a Melbourne abattoir, but rather one much closer to Sydney.[11] Therefore, Lucas Heights is ruled out as a source for the October/November 1979 iodine-131 detections in southeast Australian sheep.

Iodine-131 effluents from medical treatments

Medical treatment and diagnostics using iodine-131 could be an environmental source of iodine-131.[12] It is an isotope commonly used in nuclear medicine to treat overactive thyroid glands (hyperthyroidism) and thyroid cancer. Iodine-131 is eliminated from the body principally through urine. In some medical practices the urine is discharged directly into the local wastewater system and not treated as biomedical waste. Under these conditions, iodine-131 could be released into the biosphere, e.g. ocean, lakes, rivers, and even into recycled wastewater used for irrigation depending on the treatment method and timing.

Although not impossible, ingestion of grass irrigated with iodine-131 contaminated water by sheep is unlikely. Documentation on the precise region from which the sheep were sourced has not been found. Thus, we cannot be certain whether releases from a medical facility or a municipal sewage treatment plant could have been the origin of the iodine-131. Having said that, we note that most likely the sheep were from rural areas, far removed from a major city or even a large town (which probably would not have an iodine-131 medical treatment capability). The Naval Research Laboratory was assured (presumably by VanMiddlesworth and/or Melick) that "sheep delivered to the Melbourne slaughterhouse usually come from regions in Victoria, Tasmania, South Australia and New South Wales that were subject to rain on 26 September 1979."[13] The probability that all three thyroid samples originating from sheep slaughtered on three different dates came from the same area is very small. As seen in Figure 1 in the main text, "The 22 September 1979 Vela Incident: Radionuclide and Hydroacoustic Evidence for a Nuclear Explosion," all thyroids show evidence for the presence of iodine-131, therefore suggesting the iodine-131 was instead quite widespread.[14]

Even so, we look in some detail at the sewage treatment plant as a possible source since grazing livestock on pastoral lands collocated with sewage treatment plants has been a reasonably common practice in Australia.[15] One of the largest of these plants is the Western Treatment Plant (WTP), situated 35 km southwest of Melbourne, where the sheep were slaughtered. The WTP complex includes a cattle and sheep farm that sells livestock for human consumption to reduce operating costs of the facility. In 1979 the pastures were either directly used in the treatment process, or irrigated with treated (recycled) water. Sheep and cattle have grazed on this land for over a century. Assuming the slaughtered sheep were from this area, one might consider this as a potential source of the ingested iodine-131. This is, however, unlikely for several reasons.

The WTP has used several different waste treatment methods, sometimes concurrently. Since the 1930's, the primary method utilized large treatment ponds or lagoons. Since 1979, more than half of the treatment volume was pumped into these lagoons. As treatment proceeds, waste is transferred from lagoon to lagoon in a series. Several ranges of retention times have been reported, including 30–35 days, 40–90 days, 50–80 days or 60–70 days, depending on the information source.[16] This implies that the wastewater was retained for a minimum of four and a maximum of 11 half-lives of iodine-131, and is likely to be closer to 11 during the 1970's. Therefore, significant radioactive decay occurs before the treated water is either discharged to the ocean or used to irrigate crops or pastures. Perhaps evaporation from the lagoon system was a pathway for iodine-131 release during the hottest months of January and February, but unlikely in October. On balance, wastewater as the source of iodine-131 ingestion by VanMiddlesworth's sheep appears highly improbable 131.

Another treatment method used by the WTP was the land filtration process, which had been used by the WTP from its inception in the late 19th century and at least up until the early 21st century. Operating October through April but peaking in the summer months of January and February, land filtration only accounted for 20% or less of the annual treated volume during the 1970s. Raw sewage was flooded onto paddocks to a depth of up to 10 cm for 1–2 days, purifying the wastewater as it seeped through the soil. The ground was then allowed to dry for around a week, followed by a 2-week livestock grazing period to remove the pasture, which had grown rapidly due to the high nutrient level. Despite a retention time of around one iodine-131 half-life, almost inevitably this livestock would ingest (an indeterminate quantity of) iodine-131, which had been flushed into the wastewater system after medical treatment and/or diagnostic procedures.

Nevertheless, it is highly unlikely this is the source of the October/November 1979 iodine-131 detections. Firstly, the detections occurred at the start of the land filtration 'season' at WTP, whereas sheep were purchased in the southern spring and summer, fattened up over several months, and then sold to market at the end of the season in southern autumn.[17] An inconsistency thus exists between the times at which VanMiddlesworth's sheep showed iodine-131 and when WTP sheep would be taken to the abattoir. Secondly, by law the livestock had to be fed for a period 'off-farm' to kill off any parasites or pathogens.[18] Presumably this would take several weeks, sufficient time for any iodine-131 to decay by a few to several half-lives.

The third sewage treatment process practiced at WTP during the 1970's was grass filtration. That is not considered relevant here as only cattle have been mentioned in the literature in relation to grazing on pasture following grass filtration.[19]

The medical iodine-131 scenario has several other problems. One should not presuppose that VanMiddlesworth and his colleagues, after a quarter century of analyzing such data, their considerable experience, and being endocrinologists, would not be vigilant against the possibility of contamination of their experiments. Also, if this were the case then elevated iodine-131 would be a more common finding in their samples. But this was demonstrably not the case.

Finally, having ruled out potential alternatives, the likely source of the iodine-131 detections is the suspected nuclear explosion on 22 September.

APPENDIX B. A search for corroborative fission product detections in the southern hemisphere

Given that a candidate location for a nuclear test was near the Prince Edward and Marion Islands, at a latitude of around 50 degrees south, it might be expected that some fallout could be detected at similarly southern latitudes, such as Australia, New Zealand, Chile, Argentina, and perhaps even in Antarctica. Fallout monitoring systems were in place in these territories, motivated by France's nuclear testing program in the southern hemisphere at the Pacific Ocean Mururoa and Fangataufa atolls.[20]

On 13 November 1979 the Institute of Nuclear Sciences (INS) at Lower Hutt New Zealand claimed they had observed the short-lived fission products barium-140 (half-life = t1/2 = 12.75 d), praseodymium-143 (t1/2 = 13.6 d) and yttrium-91 (t1/2 = 58.5 d) in rainwater samples taken between 1 August and 28 October.[21] But only two weeks later that claim was retracted, inter alia, because the analysis could not be replicated either by the INS or the New Zealand National Radiation Laboratory (NZNRL).[22] The initial analysis was based on fitting decay curves to a beta radiation spectrum, a method that is suboptimal for detecting small bomb debris signals. Eventually INS and NZNRL concluded jointly that the original samples had been contaminated with natural and long-lived radionuclides, probably arising from sludge in the collection pot.[23]

Subsequent analysis by NZNRL used four filters exposed during September and October, equivalent to 26,000 m^3 of air sampled after 22 September, as well as rainwater from October from the region with highest rainfall. No indication of fresh fission products was found. A further search for barium-140 and strontium-89 using selected rainwater samples was also unsuccessful.[24]

One of the authors, De Geer, had a personal communication with the Officer in Charge of Monitoring Operations at the NZNRL in Christchurch New Zealand, Dr. Lloyd Gregory, in November 1979. During the communication, he learned that no fresh fission products had been noted either in rain or in air from its network of monitoring stations during 1979.

In New Zealand, the routine air samples were only analyzed for total beta activity. On the other hand, the Australian Laboratory maintained, since 1975 and beyond 1979, a six-station network for detection of fresh fission products.[25] The same results were reported in a personal communication between De Geer and Dr. John Moroney at the Australian Radiation Laboratory in Melbourne. In November 1979 for the Australian networks as received from New Zealand; there were no detections of bomb debris.[26] A detection limit of 30 $\mu Bq/m^3$ was claimed for iodine-131 in this system.[27] As shown in Appendix C, the non-detection of fission products in air or precipitation in 1979 was consistent with this limit.

In the further search around the southern hemisphere for corroborating detections of nuclear bomb debris in the atmosphere, in precipitation, snow and ice, only nuclides with half-lives between 0.78 years and several tens of years were found.[28] Whilst in some cases the concentrations peaked at a time suggestive of a correlation with Alert 747, these were likely to be artifacts of earlier nuclear tests. Past fallout was integrated into snow and ice at Antarctica and the atmospheric detections were examples of increased lower stratosphere to troposphere transfer, typically in the spring, from the stratospheric reservoir. The residence time in the stratosphere can be several years, depending on injection height and latitude, thus much longer than in the troposphere, where primarily precipitation quite rapidly deposits the debris on the ground. The Hadley cell circulation in the troposphere inhibits aerosols from crossing the equator. One should therefore not expect to detect radionuclides injected into the troposphere of the northern hemisphere in the southern hemisphere. Due to eddy diffusion, injections of debris into the lower stratosphere of one hemisphere can sometimes be detected at much reduced levels in the other hemisphere, but this is a process that typically takes months or years, which practically precludes detection of short-lived radionuclides.[29]

In summary, no corroborative radionuclide evidence that could be unambiguously attributed to a nuclear test on 22 September 1979 was found in air, precipitation or layers of snow and/or ice. But the words of the Ruina panel provide some perspective:

> “Positive results from the debris effort would provide conclusive evidence of a nuclear explosion. However, the negative results actually obtained do not provide conclusive evidence that no nuclear explosion occurred.”

APPENDIX C. Iodine-131 detected in sheep thyroids, but not in air

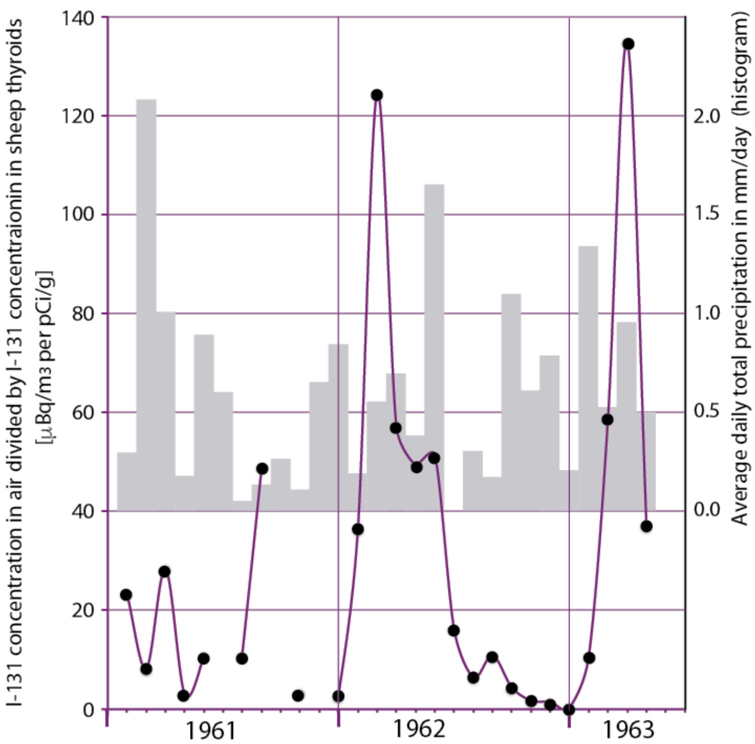
Previous experience (LVM-1) [30] had shown that the sheep thyroid iodine concentrations peak some 10–20 days after deposition on the grasslands and, as shown in Figure 3 of the main text, the potential deposition of a 22 September cloud occurred on 26 September in south-eastern Australia, which is 27 days before the sample was collected on 22 October. The previous sample was collected on 24 September, before there was any possible deposition in Australia from a potential nuclear test on 22 September near Marion Island. The 22 October sample was thus the first where any "Vela-iodine" could have been detected.

Sheep thyroid surveillance is the most sensitive method to detect man-made radioactive iodine contaminations in rural areas as there is around 10,000 times greater concentration in their glands than in their diet (LVM-1).[31] The United States Air Force Technical Applications Center (AFTAC), made a large effort to collect samples in the cloud. There were no less than 25 sorties of the U.S. atmospheric collection aircraft, WC 135B, flown from 25 September to 17 October, but nothing was found.[32] The total flight time was 230 hours, i.e. nine hours per flight. No flights crossed the low-pressure system that took the potential debris towards Australia, perhaps because of the vast estimated source area of the flash in the first week, and likely because of difficulties in locating suitable bases in such remote areas. A 1982 AFTAC report stated that Alert 747 "brought to light AFTAC's meager resources in the Southern Hemisphere."[33] Also the sensitivity of the airborne system was likely insufficient to detect any debris as the explosion would have drawn a huge amount of water into the cloud. When the water in the cloud fell back into the ocean, a large fraction of the radioactive debris would have been scrubbed from the cloud.

An interesting question is whether the thyroid data can be used to estimate the corresponding ground level iodine-131 concentrations in air. In the early 1960's Dr. Joseph Soldat studied the relationships between iodine-131 concentrations from global fallout in environmental samples such as ground level air, grass, milk and cattle thyroids in the vicinity of the Hanford Laboratories.[34] Applying the global average factors for iodine-131 concentrations in 1961 and 1962 growing season data from Hanford, Soldat determined that sheep thyroids contained about five times more iodine per gram than cattle thyroids and that the ratio of sheep thyroid concentration in pCi/g was 1.7 times the iodine-131 air concentration in $\mu Bq/m^3$. Using this estimated ratio, the iodine-131 detected in the sheep thyroids on 22 October, about 26 days after the cloud passed, implies air concentrations of around $(0.14/1.7) \times e^{\ln 2 \cdot 26/8.025} = 0.8\ \mu Bq/m^3$, which is well below the stated detection limit of 30 $\mu Bq/m^3$ in the Australian network.

The air-to-thyroid concentration ratio is sensitive to precipitation. Higher precipitation, due to higher effective rainout, corresponds to lower air-to-thyroid ratios. Dry conditions correspond to higher ratios. To illustrate this, the monthly air-to-thyroid concentration ratios were calculated from the monthly Hanford data and co-plotted with the monthly precipitation averages in Figure 1.[35] The lower factors are associated with higher precipitation, though with some delay as time needs to be allotted for pasturing before slaughter. The lowest factors, fitting the 1979 situation in Australia, are in the range of 0.4 to 3.0. The high factors in February through March of 1962 and 1963 are understood if the cattle were fed aged forage during the winter months. The conclusion here is that an Australian air sampling station with a detection limit of 30 μBq/m³ would almost certainly not have detected any iodine-131 compatible with the sheep thyroid concentrations in October 1979.

Figure 1. The ratio of iodine-131 concentrations in air to the ones in sheep thyroids during 20 months in the early 1960s near Hanford WA, USA. The grey histogram with the scale on the right shows the average daily total precipitation each month.



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