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Health and environmental impacts of British nuclear test explosions in Australia

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Nuclear test explosions

Between 1952 and 1957, the United Kingdom undertook 12 nuclear test explosions in Australia – three at the Monte Bello Islands in Western Australia, two at Emu Field, and seven at Maralinga, South Australia. These were a mixture of ground and airbursts, up to 98 kilotons (kt) in size, and supported the development of both fission weapons and thermonuclear (hydrogen) bombs (Royal Commission 1985, Vol. 1).

The major tests produced varying complex fallout patterns which contaminated the whole Australian continent, including cities, with the exception of the very southwest corner of Western Australia in the vicinity of Perth (see Maps). A 1985 Royal Commission found that the Australian Weapons Test Safety Committee failed in many of its tasks, and "at times it was deceitful and allowed unsafe firing to occur" (Royal Commission 1985, Vol. 3, Conclusion 47). Official fallout measurements were incomplete and were concealed from the public and in many cases the government (Royal Commission 1985, Vol. 3, Conclusions 2, 6, 9, 27–32, 47, 48 and others).

"Minor" trials

In addition, about 600 "minor trials" were conducted at Emu and Maralinga, between 1955 and 1963. No Australians were present at any of the minor trials, and their nature and the extent of contamination they caused were barely known until a Royal Commission examined the nuclear tests in 1985. The minor trials involved neutron initiator development trials using polonium-210 and beryllium (code-named *Kittens*); fissile material compression tests involving uranium, plutonium, beryllium and intense gamma sources (*Tims* and *Rats*); burning trials on rods of plutonium, uranium and beryllium, involving combustion and dispersion, and explosive dispersion of plutonium (*Vixen A*); and safety and development trials including detonations and subjecting nuclear weapons components and subassemblies to impacts, fire and other accidents (*Vixen B*) (MARTAC 2003, p.10-13). The *Vixen* trials pose the greatest long-term contamination hazard because they involved high explosive detonations scattering of 22 kg of plutonium over distances of hundreds of kilometres.

It was not until the 1985 Royal Commission that much of the truth about the nuclear tests emerged, particularly the "minor trials", which were not minor in their consequences and indeed were responsible for the bulk of persistent contamination. The Royal Commission described "persistent deception and paranoid secrecy", with "British authorities embarked on a course of determined concealment of information from the Australian Government" (Royal Commission 1985, Vol. 2, p.414).

The minor trials are assessed to have used the following radioactive and toxic materials (MARTAC 2003, p.13):

- 24.2 kg of plutonium (Pu)
- 15,900 kg of natural uranium/U-238
- 24 kg of enriched uranium
- 144 kg of beryllium
- 225 TBq of polonium-210
- 78.7 TBq of scandium-46
- 4.4 TBq of lead-212
- 5 MBq of actinium-227

Inadequate measurements led to the levels of plutonium reported by the UK in 1968 being about an order of magnitude (ten-fold) lower that field results measured by the Australian Radiation Laboratory in 1985 (MARTAC 2003, p.27).

High energy and temperature dispersal of plutonium and uranium in the Vixen B trials created myriad tiny heterogeneous micron-sized radioactive 'hot' particles. Oxidation and mobility of uranium is widespread in the environment. Most hot particles contain low valence plutonium-uranium-carbon compounds which are chemically reactive, but initially protected by their inclusion in metallic alloys. Chemical and physical weathering likely result in long-term, slow release of plutonium into dust or groundwater, now mobile and bio-available to be taken up by wildlife. Plutonium particles released by weathering are not only mobile, but smaller, increasing their surface area and the radiological risk associated with plutonium's alpha emission. Nano-particle-facilitated transport of plutonium in groundwater has been identified at the Nevada Test Site, Rocky Flats and Hanford in the US, at Mayak in Russia, and at Chernobyl (Ukraine), Sellafield (UK) and Marcoule (France) (Cook et al, 2021).

Aboriginal people

Those at highest radiation exposure risk were local Aboriginal people and pastoralists, who were not systematically evacuated or even informed; and over 16,000 workers directly exposed to the tests (Gun et al 2006, p.xvii). Warning signs in English were usually incomprehensible to the Aborigines. Some were enveloped and irradiated by local fallout (the "Black Mist" phenomenon after the Totem 1 test on 15 October 1953) sufficient for a high proportion of inhabitants of the communities of Wallatina and Mintabie and neighbouring homesteads in northern South Australia to develop typical symptoms of acute radiation sickness, signifying a high level of acute radiation exposure, after the first test at Emu Field (Totem 1) (Royal Commission Report 1985, Vol. 3, Conclusion 97, and Vol. 1, para. 6.4.92, p. 194 and accompanying account pp. 174–194). The Royal Commission concluded

that the phenomenon had been real, despite earlier denials by various British and Australian officials.

The Royal Commission report was scathing about the appalling treatment of indigenous Australians during the tests. Aboriginal people were within prohibited zones and lived in them during and for up to six years after tests. Officials responsible for their safety demonstrated "ignorance, incompetence and cynicism" and failed to consider "their special vulnerability to radioactive fallout". The Royal Commission assessed that decades of denial of access to their traditional lands by Aboriginal people "contributed to their emotional, social and material distress and deprivation" (Royal Commission 1985 Vol. 1, p. 319, 323, and Royal Commission, Vol. 3, Conclusions 90, 91, 117, 124–125, 140, 186).

Aboriginal people were put in double jeopardy by being disproportionately exposed to test radiation, and through greater radiation exposure that is associated with traditional and cultural practices - often involving dusty play environments for children, walking barefoot, light clothing, sitting and sleeping on the ground, hunting, gathering and eating local foods, cooking on open fires, being on and taking care of country and ceremonies. These are associated with increased soil and dust ingestion and inhalation (Haywood and Smith 1990).

Important documentation of the experience of the inhumane impacts of the British nuclear tests on Aboriginal people includes Yalata 2009 (Yalata and Oak Valley communities, with Christobel Mattingley. *Maralinga. The Anangu story.* Crows Nest: Allen & Unwin, 2009) and Lester 1993 (Yami Lester. *Yami.* 2nd ed. Alice Springs: Jukurrpa Books, 2000).

Test site workers

Permissible radiation dose limits for whole-body penetrating radiation for workers from 1950 were 5 millisieverts (mSv) per week (Royal Commission 1985, Vol. 1, p. 39–85, especially Table 4.5.1, p. 78), compared with current occupational limits averaging 20 mSv per year and 1 mSv per year for the public. Yet measures to comply with even the low standards of the time were frequently deficient. Veterans describe lack of protective clothing and equipment, soldiers sent into ground zero the same day after an explosion, and unpressurized aircraft flying through fallout clouds (Royal Commission 1985, Vol. 1). The Royal Commission described "departures, some serious and some minor, from compliance with the prescribed radiation protection policy and standards" (Royal Commission 1985, Vol.3, Conclusion 52, p. 12). Despite no more than 4% of veterans having radiation film-badge data available, external exposures of more than 400 mSv (following the first Monte Bello test) were documented (Royal Commission 1985, Vol. 3, Recommendation 52 and Royal Commission, Vol. 1 p.125-6).

Accounts from test participants provide illuminating evidence about the conduct, monitoring, working conditions and health and safety management. Some of the most informative accounts are those by Tynan 2016 (Elizabeth Tynan. *Atomic thunder*. Sydney: NewSouth Publishing, 2016), Walker 2014 (Frank Walker. *Maralinga*. Sydney: Hachette Australia, 2014) and Cross and Hudson 2005 (Roger Cross, Avon Hudson. *Beyond belief*. Kent Town: Wakefield Press, 2005).

A belated government-funded mortality and cancer study of test veterans was concluded in 2006. Despite a "healthy worker effect" (evident in reduced non-cancer mortality rates) and major methodological limitations of a retrospective study with incomplete data fifty years after the nuclear tests began, it found statistically significant 23% higher rates of cancer and 18% higher cancer mortality between 1982 (29 years after the first test) and 2001 in veterans exposed to nuclear tests compared with the general population (Gun et al 2006).

Clean-ups

A hasty British clean-up in 1967 involving ploughing and disc-harrowing of plutonium-contaminated areas, and shallow burial of material from 180 hectares of heavily contaminated land (which was then declared "radiologically safe"), led to a 1968 agreement between the British and Australian governments releasing Britain from liability for any future claims related to its nuclear tests (Royal Commission 1985, Vol. 2, p.539-40). However, a 1984 study by the Australian Radiation Laboratory demonstrated far more extensive and severe contamination than had previously been revealed, proving invalid the information and hazard assessment on which the 1968 agreement had been based (Royal Commission 1985, Vol. 2, p. 539–540, 549–552). The Commission recommended that "action should be commenced immediately to effect the clean-up of Maralinga and Emu … so that they are fit for unrestricted habitation by the traditional Aboriginal owners as soon as practicable", and that "[a]ll costs of any future clean-ups at Maralinga, Emu and Monte Bello Islands should be borne by the United Kingdom Government" (Royal Commission 1985, Vol. 3, recommendations 3 and 6).

Maralinga was declared 'safe' in 2000 after a second limited A$108 (US$76) million clean-up funded by both governments, despite expert concerns and failure to implement the planned process of immobilizing plutonium fragments through *in situ* vitrification after an explosion occurred in a pit (Alan Parkinson. Maralinga: The Clean-Up of a Nuclear Test Site. *Medicine & Global Survival*, Vol. 7, No. 2, 2002; 77-81; Alan Parkinson. The Maralinga Rehabilitation Project: Final Report. *Medicine, Conflict and Survival*, Vol. 20, No. 1, 2004; 70-80). During the clean-up 1994-9, 40 ground zero sites were found rather than the 26 documented by the UK, additional waste pits were found, thousands of tonnes of contaminated debris were identified beyond pit boundaries, and at least 3 contaminated sites were found by accident (Alan Parkinson, *Maralinga: Australia's Nuclear Waste Cover-up.* Sydney: ABC Books, 2007).

A region of 412 km^2 marked with boundary markers remains unsuitable for permanent occupation with boundary markers that will last fifty years, while half the plutonium-239 will still be there in 24,400 years (Alan Parkinson. Maralinga: The Clean-Up of a Nuclear Test Site. *Medicine & Global Survival*, Vol. 7, No. 2, 2002). This area enclosing most of the *Vixen B* plumes from Taranaki is notionally restricted to traditional hunting and transit on the basis that radiation exposure with unrestricted use could be expected to be over 5 mSv/y, and up to 13 times greater within that area (Alan Parkinson. Maralinga: The Clean-Up of a Nuclear Test Site. *Medicine & Global Survival*, Vol. 7, No. 2, 2002). However official estimates by the end of the clean-up suggested radiation doses at the boundary were unlikely to reach greater than 1mSv/y (MARTAC 2003, p366). Less than 2% of contaminated areas clean-up at the Taranaki "minor trials" site meet the clean-up clearance criteria of less than 3 kBq americium-241/m^2 (based on the 1998 plutonium:americium ratio), and 84% of the

plutonium contamination remains on the surface, (Alan Parkinson. Maralinga: The Clean-Up of a Nuclear Test Site. *Medicine & Global Survival*, Vol. 7, No. 2, 2002); yet no further clean-up is planned.

Numerous other sites underwent soil removal (individual areas up to 1.5 km^2), and/or contain disposal pits and burial trenches containing concentrations of radioactive and toxic material (MARTAC 2003, Chapter 6). In 2011, a report obtained under Freedom of Information laws documented that only a decade on, a number of traditional burial pits have been subject to subsidence and erosion, requiring further remediation (Dorling 2011).

Unresolved issues many decades later include remaining contamination, inadequate clean-up of test sites, indigenous dispossession, and inadequate compensation for Aboriginal people, ex-military personnel and civilians for their hazardous exposure, illness and loss. In 2006, 54 years after the tests began, the government announced provision of free care for cancers to all test participants (military, public servant and civilian), and in 2010 military veterans were extended the same benefits as veterans involved in operational service or service recognized as "hazardous" (Department of Veterans Affairs 2022). In 2017, a Veteran Gold Card supporting comprehensive health care was made available to all Australian participants in British nuclear tests, including certain civilians within limited areas within 10-40 km of test sites. This excludes for example, those subjected to the Black Mist. However, there is still no readily available compensation for those exposed. For survivors, time is running out. In 2001, 40% of test participants were confirmed to have died (Gun et al 2006, p. xvii).

Unethical research

The conduct of much research and monitoring of fallout from nuclear tests has been seriously deficient in ethical conduct, respect for human rights, transparency and accountability. An Australian example is an extensive programme of sampling of human bones for strontium-90. From 1957 to 1978, hospital pathology services were paid to remove sometimes quite sizeable samples of bone from about 22,000 bodies at autopsy, particularly of infants and children. In the 1950s and 1960s, samples were sent to the United Kingdom or United States (under "Project Sunshine") for testing. Permission was not sought from families, who were not aware of the programme or the fact that many remains were kept without their knowledge or consent for decades (Australian Health Ethics Committee, National Health and Medical Research Council. *Ethical and Practical Issues Concerning Ashed Bones From the Commonwealth of Australia's Strontium 90 Program, 1957–1978.* Advice of the Australian Health Ethics Committee to the Commonwealth Minister for Health and Ageing, Senator the Honourable Kay Patterson, Canberra, March 2002, p. 4-6). There are disturbing reports of families being denied access to their dead children's bodies or not being able to bury them after bones had been removed, of foetuses having been discarded, and of children having been buried anonymously (Frank Walker. *Maralinga*. Sydney: Hachette Australia, 2014, p. 218-30).

This study was one of approximately 4,000 human radiation experiments conducted under the auspices of the US Atomic Energy Commission over the period 1944–74. Some involved significant health risk to subjects; in some experiments, patients were subjected to

sufficiently high doses to develop acute radiation sickness, which was sometimes fatal (Advisory Committee 1995, p. 779).

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Acknowledgement
Thank you to Alan Parkinson for permission to reproduce the Taranaki contamination map.

Maps:

Distribution of fallout over Australia from various nuclear test explosions

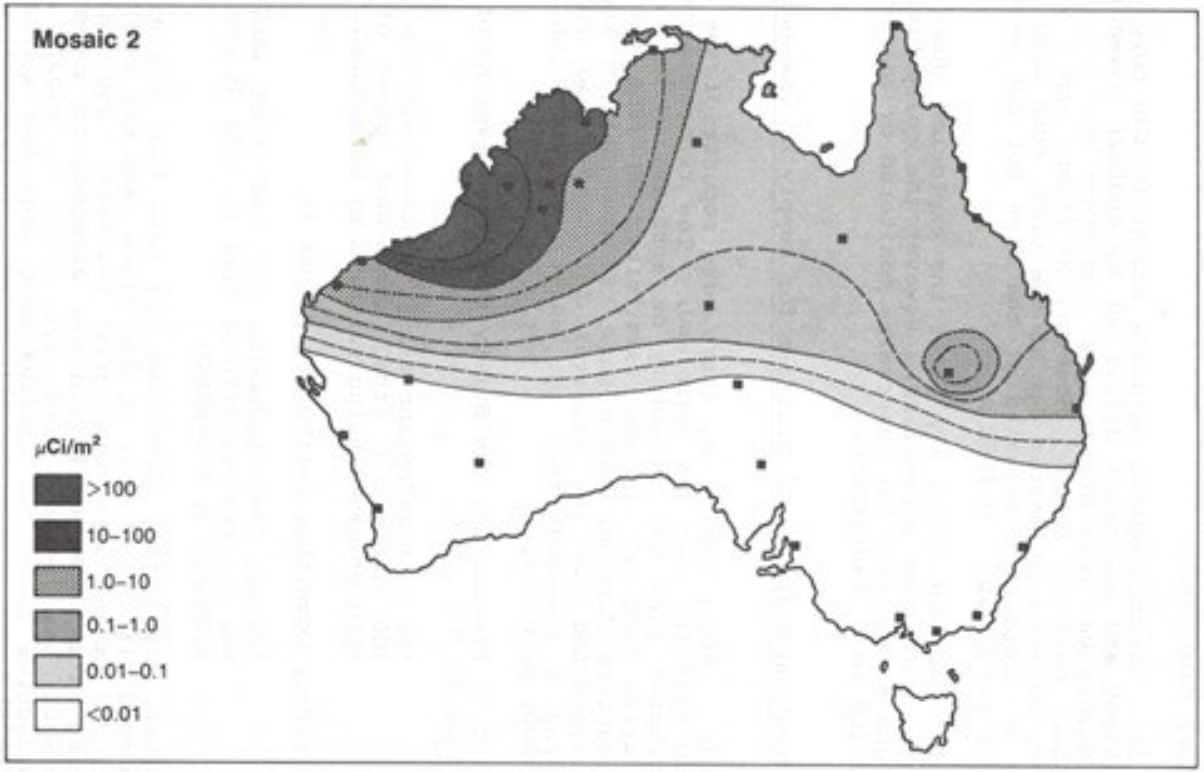
Note: 1 microcurie = 37,000 becquerel (Bq) = 37 kBq

Source: Royal Commission 1985, Vol 1

FIGURE 7.4.2

MOSAIC 2

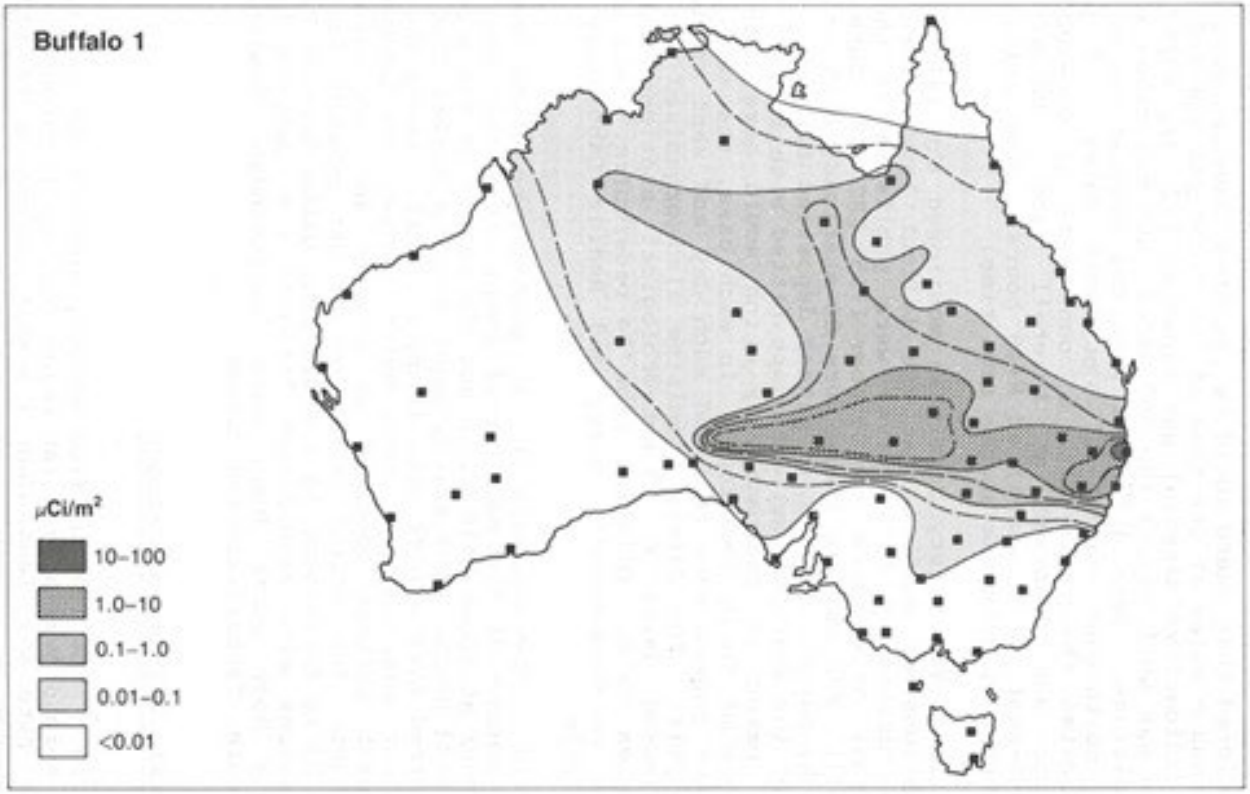
The Distribution of Fallout over Australia from the Test. The contours show the total amount of radioactivity recorded by the sticky paper collectors. The squares show the locations of the fallout stations.



Data from Butement et al. 1957

FIGURE 8.3.2

The Distribution of Fallout over Australia from the Buffalo 1 Test. The contours show the total amount of radioactivity recorded by the sticky paper collectors. The squares show the locations of the fallout stations.

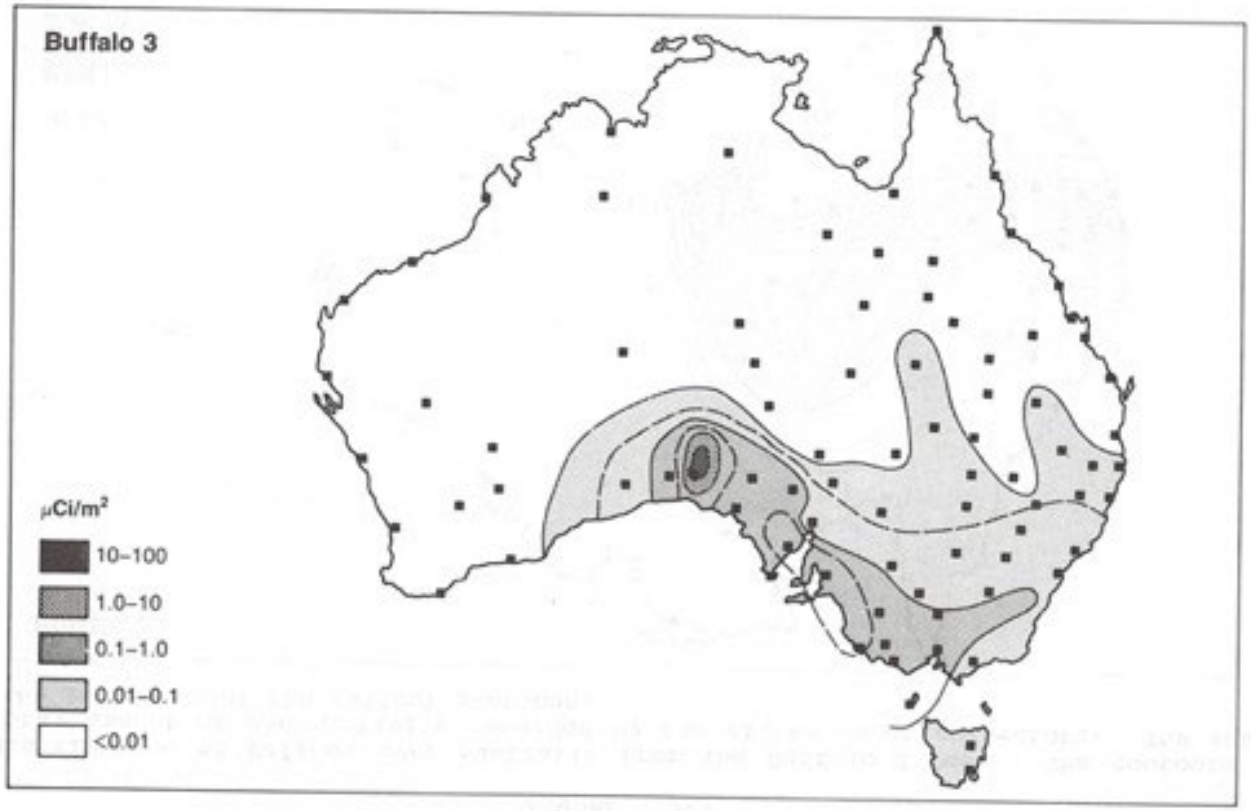


Data from Butement et al. 1958

P.O. Box 5324, Takoma Park, MD 20913. Phone 301-509-6843. Website: www.ieer.org

FIGURE 8.3.5

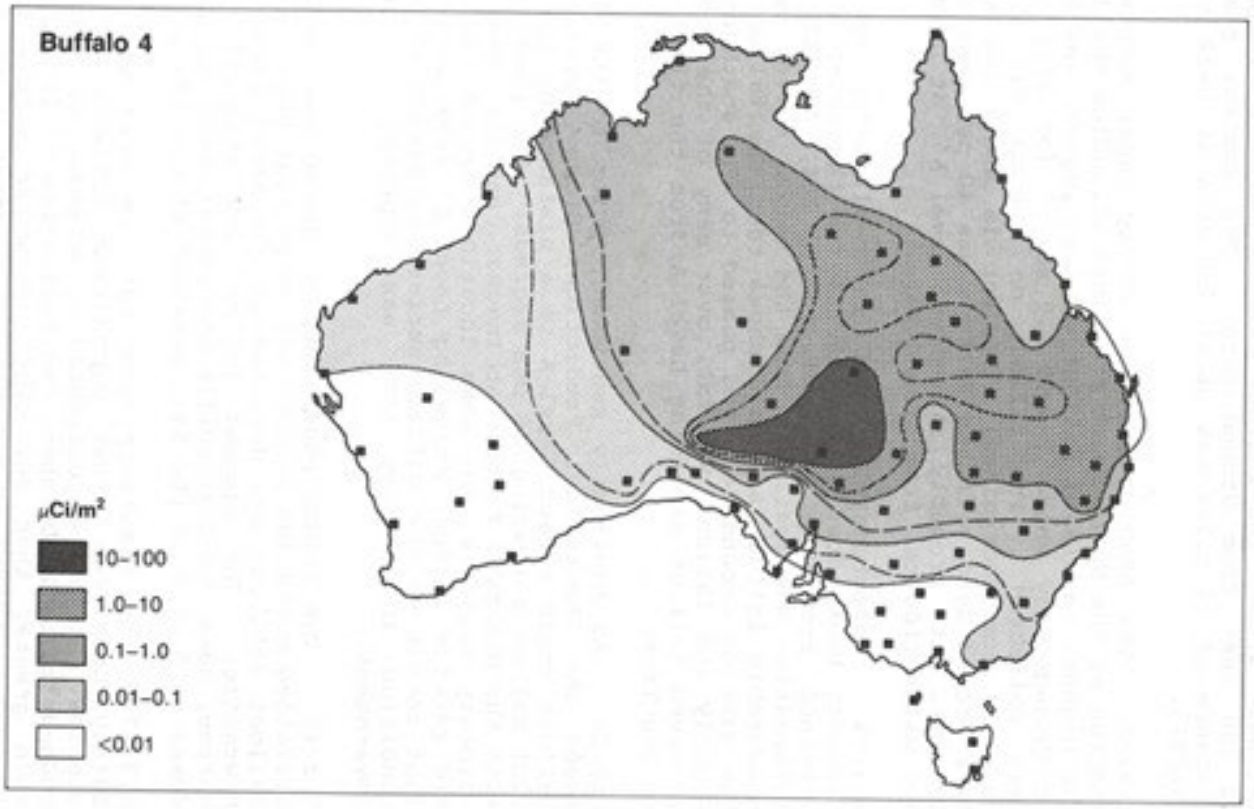
The Distribution of Fallout over Australia from the Buffalo 3 Test. The contours show the total amount of radioactivity recorded by the sticky paper collectors. The squares show the locations of the fallout stations.



Data from Butement 1958

FIGURE 8.3.6

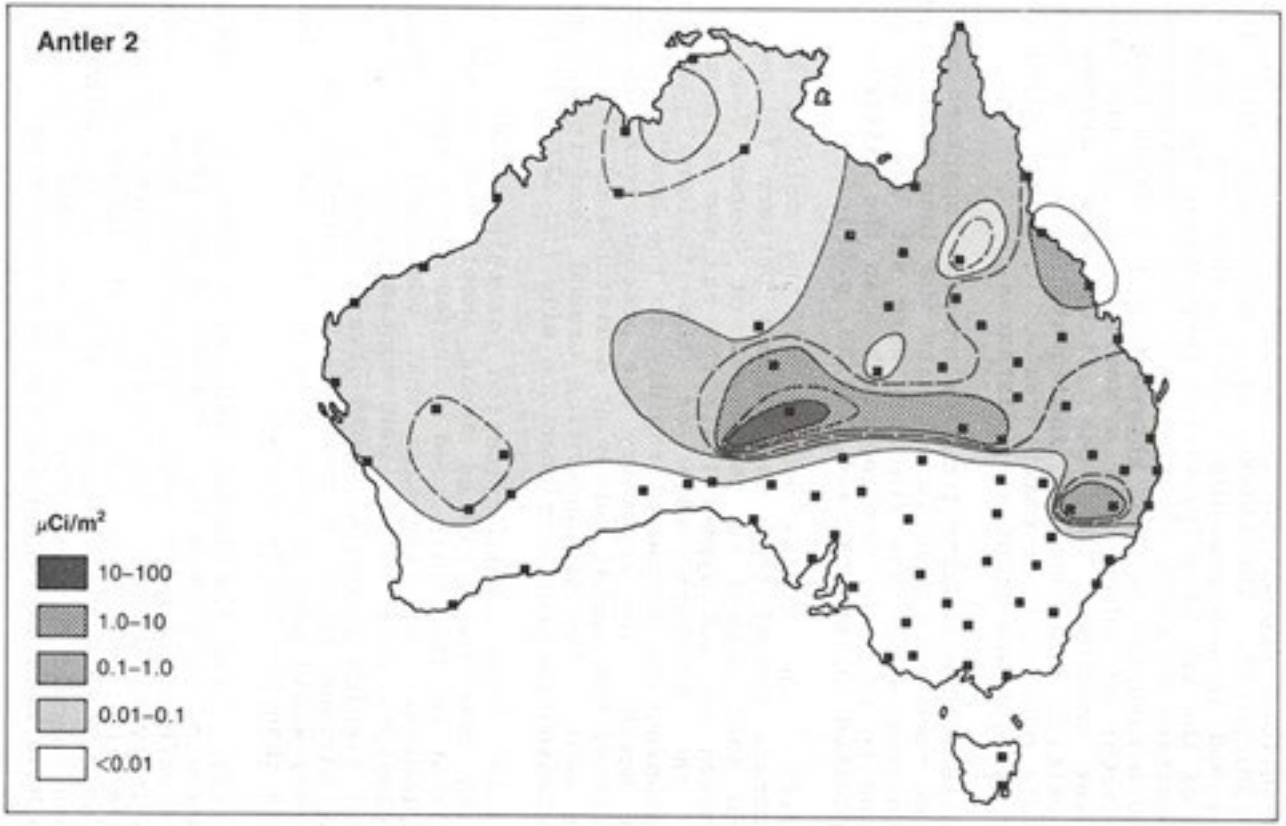
The Distribution of Fallout over Australia from the Buffalo 4 Test. The contours show the total amount of radioactivity recorded by the sticky paper collectors. The squares show the locations of the fallout stations.



Data from Butement 1958

FIGURE 9.2.2

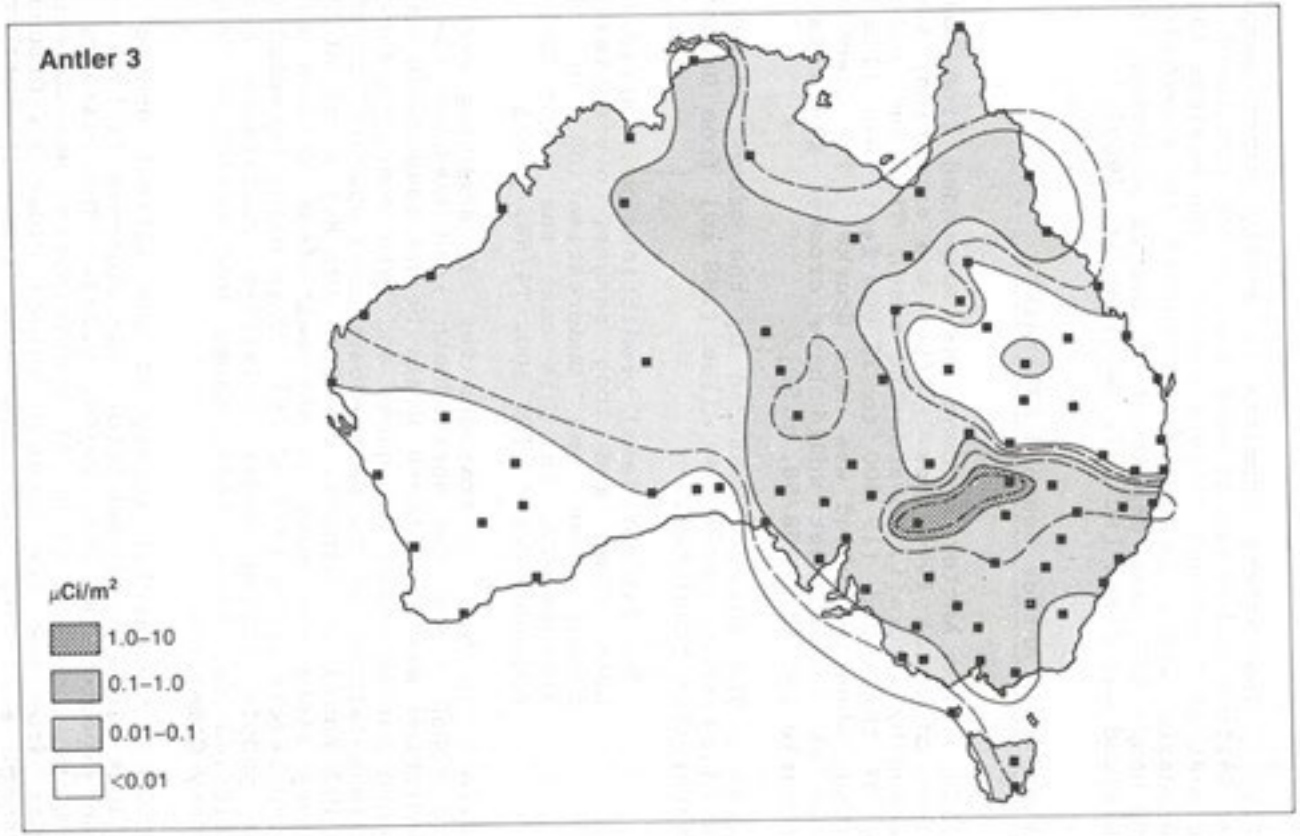
The Distribution of Fallout over Australia from the Antler 2 Test. The contours show the total amount of radioactivity recorded by the sticky paper collectors. The squares show the locations of the fallout stations.



Data from Dwyer et al. 1959

FIGURE 9.2.3

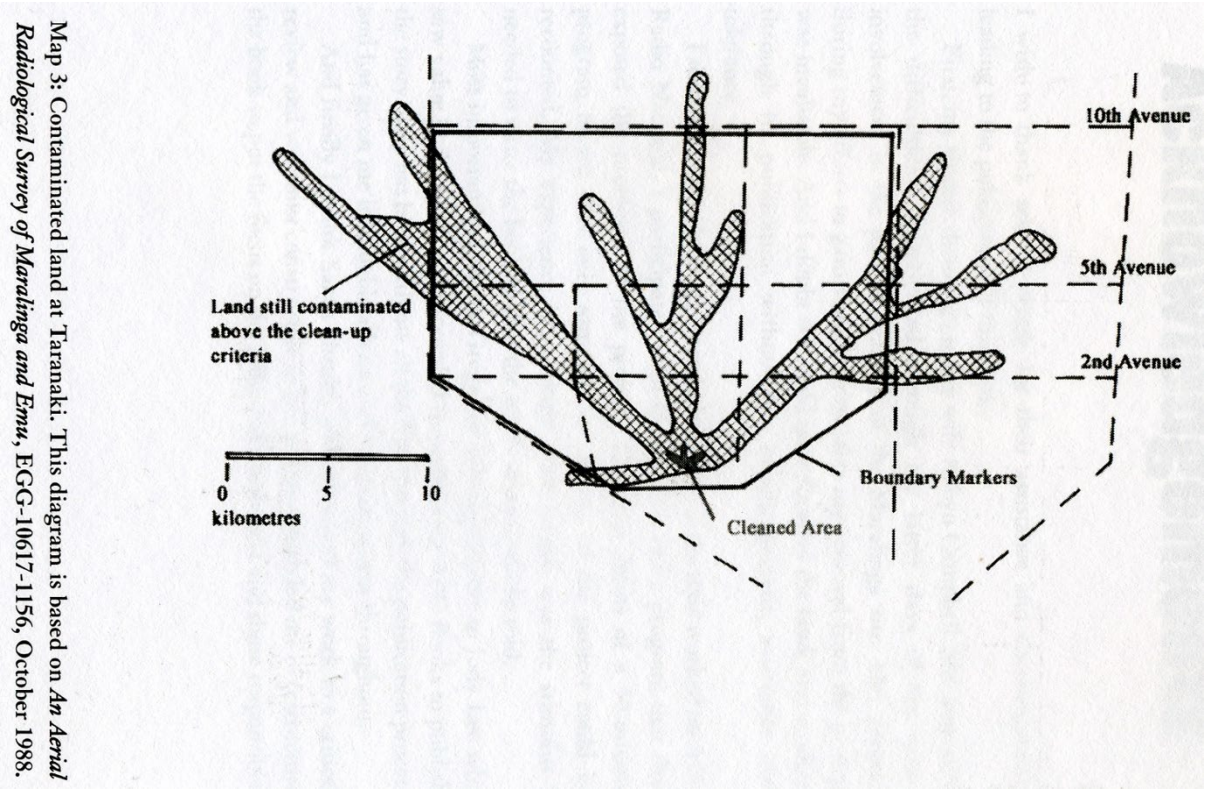
The Distribution of Fallout over Australia from the Antler 3 Test. The contours show the total amount of radioactivity recorded by the sticky paper collectors. The squares show the locations of the fallout stations.



Data from Dwyer 1959

Plutonium contamination at Vixen B trial site, Taranaki, Maralinga

Source: Parkinson 2007, p231 (used with permission).



Alternative map version: