Plutonium particles from nuclear testing more complex than previously thought

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More than 100 kg of highly toxic uranium (U) and plutonium (Pu) was dispersed in the form of tiny 'hot' radioactive particles after the British detonated nine atomic bombs in remote areas of South Australia,

including Maralinga.

Scientists say that these radioactive particles persist in soils to this day, more than 60 years after the detonations. Previously, we had limited understanding of how Pu was released from these "hot" particles into the environment for uptake by wildlife around Maralinga.

But now, a new study published today in *Scientific Reports* and led by Monash University researchers warns that the particles are actually more complex and varied than previously thought. This means that the processes which slowly release Pu into the environment are also much more complex and varied.

"The British detonated nine nuclear bombs and conducted hundreds of nuclear tests in outback South Australia between 1953 and 1963," said lead study author Megan Cook, a Ph.D. student from the Monash University School of Earth, Atmosphere and Environment. "The resulting radioactive contamination and cover-up continues to haunt us."

"The results of our study profoundly changes our understanding of the nature of hot particles at Maralinga—despite the fact that those were some of the best studied particles anywhere in the world," said study co-author Associate Professor Vanessa Wong.

The research team used synchrotron radiation at the Diamond Light Source near Oxford, UK to decipher the physical and chemical make-up of the particles.

At Monash University they dissected some of the hot particles using a nano-sized ion beam, and further characterised the complex make-up of these particles down to the nano-size in exquisite details.

The researchers demonstrated that the complexity of the hot particles

arose from the cooling of polymetallic melts from thousands of degrees Celsius in the explosion cloud during their formation.

"We found that the particles contained low-valence plutonium-uranium-carbon compounds that are typically highly reactive, yet, had been stabilised in the hot-particle matrix for nearly 60 years," said corresponding author Dr. Barbara Etschmann.

Between 1950 and 1988 alone there were more than 230 recorded nuclear weapon accidents, including at least 10 with documented release of radioactive particles into the environment. The risks of such incidents are only increasing as international treaties such as the Intermediate-Range Nuclear Forces Treaty were cancelled.

"Understanding the fate of hot particles in the unique setting of the Australian outback is critical for securing Australia in case of nuclear incidents in the region, and returning all the native land affected by the British tests to the traditional Anangu owners of the Maralinga Tjarutja lands," said study co-author Professor Joël Brugger.

More information: Megan Cook et al, The nature of Pu-bearing particles from the Maralinga nuclear testing site, Australia, *Scientific Reports* (2021). DOI: 10.1038/s41598-021-89757-5

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