Abstract: In the 1950s and 1960s, a series of the British nuclear weapons tests were conducted at different sites in Australia, resulting in the significant dispersion of long-lived and highly radioactive nuclear debris. A reliable assessment of the environmental impact of these radioactive contaminants and their potential implication for human health requires an understanding of their physical/chemical characteristics. This study focuses particularly on the physical/chemical characterisation of the Pu contaminant, the most problematic radioactive contaminant remaining at the former testing sites, by synchrotron-based X-ray microscopy / spectroscopy. The chemical transformation of the Pu contaminant in the relevant environment over the last 50 years and the potential implication for radioecology will be discussed.