

Pervasive Presence of Plutonium Dioxide “Hot” Particles in Soils Near Rocky Flats

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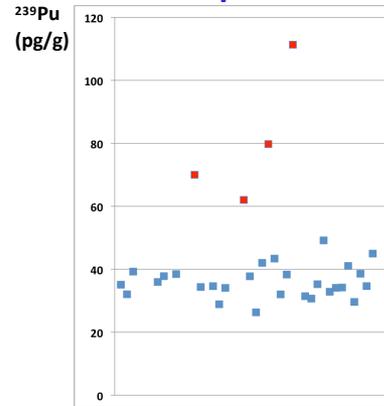
Background: Soils from the Rocky Flats National Wildlife Refuge and surroundings contain elevated levels of plutonium (Pu). While Cold War-era thermonuclear testing fallout is responsible for some Pu inventory, Rocky Flats-affected soils contain grossly elevated $^{239+240}\text{Pu}$ inventories. Plutonium from Rocky Flats is present in two distinct forms: i) uniformly dispersed on surfaces of large numbers of soil particles, originating from 903 Pad contamination; and ii) individual, micron-size “hot particles” of pure plutonium dioxide (PuO_2), from episodic fires and routine PuO_2 aerosol emissions from plant operations. *Decades of USDOE and CDPHE studies to date have failed to recognize and characterize Rocky Flats originating PuO_2 particles and have not assessed their risks to human health.* In August 2019, Engineering Analytics and ALS Laboratories, under contract with the Jefferson Parkway Public Highway Authority, encountered a lab result of $264 \text{ pCi/g } ^{239+240}\text{Pu}$. The JPPHA correctly interpreted the result as stemming from the presence of a single 8.8 micrometer (μm) diameter particle in a one gram portion of soil collected on non-US Government property along the Indiana St. corridor.

Purpose: To investigate the possible presence of discrete PuO_2 grains, referred to as “hot particles” in soils from the Indiana St. corridor.

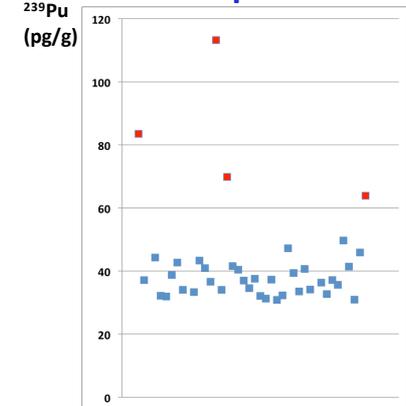
Methods: Surface soil composites (0-5 cm) were collected in 2019 from the Jefferson County right-of-way along Indiana Street, and in 2000-2002 from the Westminster open space property to the east of Indiana Street (locations approximate). Soils were dried and the $< 75 \mu\text{m}$ fraction was analyzed. For each soil, 40-50 portions of 0.2 grams of soil was dissolved using molten potassium hydroxide; Pu was separated, and the mass of ^{239}Pu in each sample was measured vs. an added ^{242}Pu tracer using inductively coupled plasma mass spectrometry.

Results: The Figures below illustrate the mass concentrations, in picograms ^{239}Pu per gram soil, found in multiple 200 mg portions of selected offsite soils. The $^{240}\text{Pu}/^{239}\text{Pu}$ atom ratios for all measurements indicate $\sim 100\%$ Rocky Flats origin; note that $15 \text{ pg/g } ^{239}\text{Pu}$ is $\sim 1 \text{ pCi/g } ^{239}\text{Pu}$ or $1.2 \text{ pCi/g } ^{239+240}\text{Pu}$. It is apparent that there is a baseline ^{239}Pu concentration that stems from the uniformly dispersed soil Pu, although obvious outliers of higher ^{239}Pu concentration are encountered. The ^{239}Pu mass difference above the baseline corresponds to the mass and size of an individual PuO_2 particle. *The PuO_2 particles detected in the Jefferson County ROW and in the Westminster open space are in the respirable size range of $0.5 - 2.0 \mu\text{m}$.*

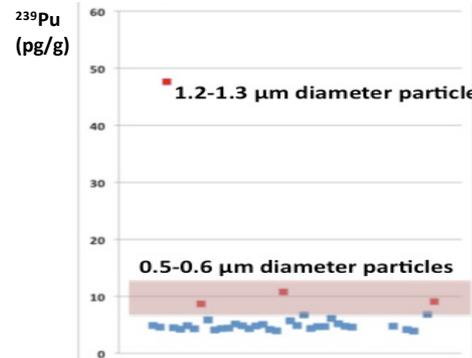
Composite 1



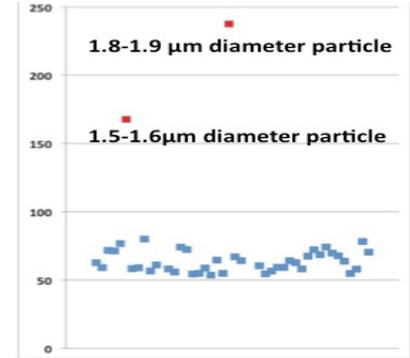
Composite 2



RF-28



Composite 3



Summary: Rocky Flats vicinity soils exhibited multiple “hot particles” of PuO_2 in every location investigated. The particles detected are mainly in $0.5 - 2.0 \mu\text{m}$ size range. *Particles of these dimensions are amenable to transport under strong wind conditions, and represent a grave hazard for human inhalation and pulmonary retention.*