

2017 Scientific Advisory Committee Meeting
Red Lion Hanford House, Richland, WA
August 25 – 26, 2017

USTUR Research: Land of Opportunity

Maia Avtandilashvili, Ph.D.
m.avtandilashvili@wsu.edu

Assistant Research Professor
College of Pharmacy, Washington State University
1845 Terminal Drive, Suite 201, Richland, WA 99354
www.ustur.wsu.edu

*“Learning from Plutonium
and Uranium Workers”*





EURADOS → Working Group 7 Annual Meeting
KIT, Karlsruhe, Germany
February 27 – March 3, 2017

M. Avtandilashvili, SAC 2017: Land of Opportunity



From Data Collectors to Data Users





Research Opportunities

- Actinide biokinetics and dosimetry
- Radionuclide distribution in human body
- Decorporation modeling
- More ...





Plutonium Biokinetics



Pu-239 Soluble Material

- U(you)P(ee)PU Club: 26 workers exposed at Los Alamos during 1943 – 1945
- 14 of them are USTUR Registrants
 - ✓ 6 whole-body donations
 - ✓ 5 partial-body donations
 - ✓ 2 living Registrants
 - ✓ 1 special study case
- Follow-up data: chest counts, urine
 - ✓ From 3 to 100+ positive urine measurements



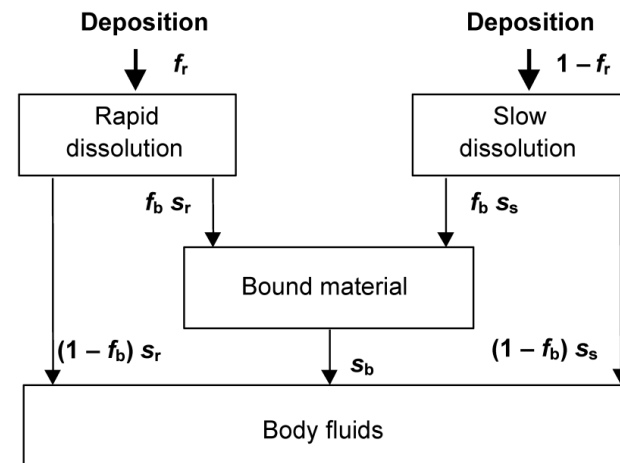
<http://permalink.lanl.gov>





Long-term Retention in the Upper Airways

- Whole-body Cases 0631 and 0745
- USTUR/PNNL collaboration
- Plutonium bound fraction



Lung Clearance: Absorption to Blood

Tolmachev SY. Technical Report USTUR-0379-15; Richland, WA, 2013

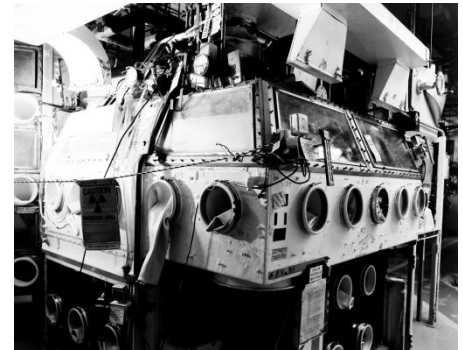
M. Avtandilashvili, SAC 2017: Land of Opportunity





Pu-239 Refractory Particles

- 'High-fired' PuO₂ aerosols
 - ✓ Generated at 1800°C
 - ✓ Particle size: 1 μm AMAD
- 22 USTUR Registrants involved
 - ✓ 5 whole-body donations
 - ✓ 16 partial-body donations
 - ✓ 1 living Registrants
- Follow-up bioassay: chest counts, urine, feces
 - ✓ From 1 to 60+ positive urine measurements



<https://www.lm.doe.gov>





Pu-239 Contaminated Wound

- 14 USTUR Registrants with wound as primary intake
 - ✓ 4 whole-body donations
 - ✓ 8 partial-body donations
 - ✓ 2 living Registrants
- No chelation treatment
- Follow-up bioassay: wound counts, urine
 - ✓ From 1 to 94 positive urine measurements



Fifty-two Year Follow-up Study

- USTUR Case 0820: *living*
- Puncture wound to the right hypothenar pad
 - ✓ Depth: ~1 cm
- Initial ^{239}Pu deposition: 11 kBq
 - ✓ 1.6 kBq measured after immediate tissue excision
- Nodule excised 51-y later
 - ✓ 632 Bq removed
- A total of 13 wound counts
 - ✓ Latest estimate: 1.9 ± 0.2 kBq

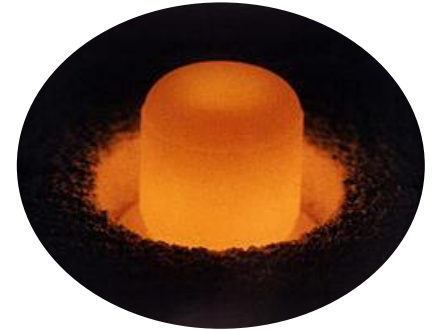


Falk RB, Daugherty NM, Aldrich JM et al. *Health Physics* 2006; 91 (2): 128-143



Pu-238 as Primary Radionuclide

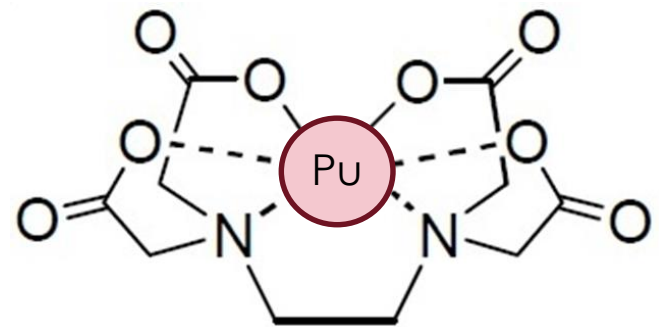
- 10 USTUR Registrants
 - ✓ 2 whole-body donations
 - ✓ 6 partial-body donations
 - ✓ 2 living Registrants
- Follow-up bioassay: chest counts, urine
 - ✓ From 10 to 300+ positive urine measurements



<https://en.wikipedia.org>



Pu/Am Decorporation





Plutonium

- Treatment: Ca-EDTA, Ca/Zn-DTPA
- 15 USTUR Registrants
 - ✓ 7 whole-body donations
 - ✓ 6 partial-body donations
 - ✓ 2 living Registrants
- 'USTUR Chelation Model': Case 0269

James AC, Sasser LB, Stuit DB et al. *Radiat Prot Dosim* 2007; 127(1-4): 449-455

- Pu decorporation after complex exposure: Case 0785

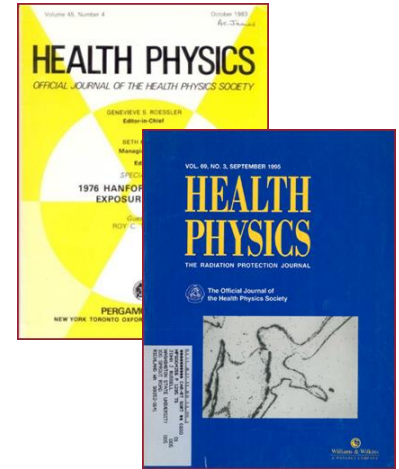
Sara Dumit. *Plutonium Excretion Following Chelation Treatment*



Americium

- USTUR Case 0246: '*Atomic Man*'
 - ✓ Highest recorded ^{241}Am intake: $> 40 \text{ MBq}$
 - ✓ 4 year DTPA therapy
 - ✓ Treatment efficacy factor: 80

Carbaugh E. *Health Physics* 2017; In preparation



- USTUR Case 0846
 - ✓ Initial systemic deposition: 66.7 kBq
 - ✓ 7 year DTPA therapy
 - ✓ Post-mortem activity in skeleton: 26 kBq

Breustedt B et al. *Health Physics* 2017; In preparation



Uranium Distribution and Biokinetics



Occupational Exposure

- 33 USTUR Registrants

- ✓ U-natural: 17
- ✓ U-enriched: 5
- ✓ U-depleted: 3
- ✓ Unknown: 8



<https://en.wikipedia.org>

- Follow-up bioassay: urine, chest counts

- ✓ From none to 300 positive urine measurements





Uranium Distribution in Human Body

- Uranium in man
 - ✓ No occupational exposure to U
 - ✓ Five plutonium workers
- Uranium in woman
 - ✓ Medical exposure to Thorotrast (^{232}Th)
 - ✓ No radiation workers
 - ✓ Two whole-body donors

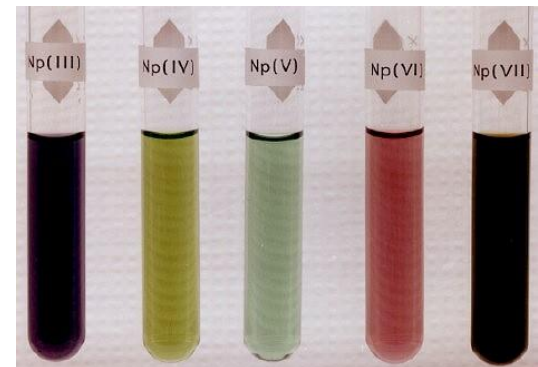


Minor Actinides: Np-237 and Cm-244



Neptunium-237

- Partial-body Case 0605: *living*
- Single acute inhalation
- Estimated ^{237}Np intake: **15 Bq**
- Three positive urine measurements
- Major exposure to $^{238}\text{PuO}_2$



<https://en.wikipedia.org>





Curium-244

- Partial-body Case 0587: *living*
- Single acute inhalation
- Estimated ^{244}Cm systemic deposition: 1.3 kBq
- Potential exposure to enriched uranium



<https://en.wikipedia.org>





Other than Actinides



Non-Radioactive Materials

- Beryllium
 - ✓ 6 whole-body donations
 - ✓ Self-reported exposure to Be over 6 – 27 years
- Zirconium
 - ✓ Whole-body Case 0303
 - ✓ Documented chronic exposure to Zr
- *Other stable metals : 20+ whole body donors*





Questions ?

