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Argonne NATIONAL LABORATORY

THE EFFECTS OF CONTAMINANT AGING ON DECONTAMINATION OF CONCRETE SURFACES - 20412

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INTRODUCTION

- Large-scale nuclear contamination releases result in adverse consequences
- Reduce consequences by compressing the late-phase recovery/remediation timeline
- Need to understand changes in decontamination efficacy weeks after contamination event
- Decontamination efficacy changes may depend on contaminant form and decontamination method

Figure 1. Field-demonstration of IWATERS vehicle decontamination.

CONTAMINATION AGING EXPERIMENTS

- Aged contamination 1, 3, 5, 8, 15, 23, 35, 48, or 59 days
- Coupons aged in ambient lab conditions (avg. 65% - 75% R.H. and 20°C) with or without precipitation events
- 1 mL of artificial rainwater aliquoted onto coupons every 2 – 4 days to mimic precipitation event; 3 – 5 hr application time
- Decontaminated samples with low-pressure or high-pressure application of 0.1M KCl solution, quintuple samples
- Measured subsurface migration of contaminants over time in duplicate

MATERIALS

- Concrete monoliths 3.1 cm diameter, surface roughness range ~0.3 – 0.5 mm with slight dipping
- Contaminants were soluble Cs-137 and surrogate fallout particles sized 0.5 µm and 2 µm tagged with Sb-125 or Gd-153 and Eu-152 respectively
- Coupon activity was measured with a HPGe detector 10 minutes before and after decontamination

Figure 2. Coupons drying after contamination.

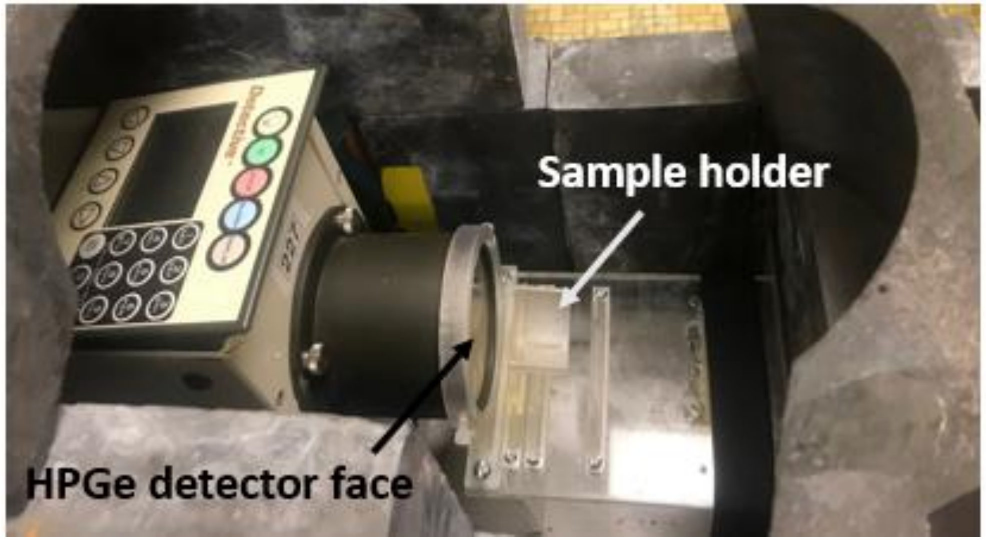


Figure 3. Ortec HPGe detector setup

DECONTAMINATION METHODS

- Low-pressure flow tests pumped solution across contaminated coupons for 15 minutes at 100 mL/min
- Pressurized washing used a 140-bar pressure washing outfitted with a 15° nozzle held 27 cm from the contaminated surface
  - Coupons were washed for about 5 seconds

DEPTH PROFILE MEASUREMENTS

- Coupon counted on HPGe before and after test
- Measured coupon dimensions and mass before test
- Removed top-layer of coupon surface using 100 grit sandpaper and place shavings in gamma tube
  - Weigh coupon before and after layer removal
  - Repeat 20+ times
- Counted each layer for 30 min on Perkin Elmer NaI(Tl) well-detector

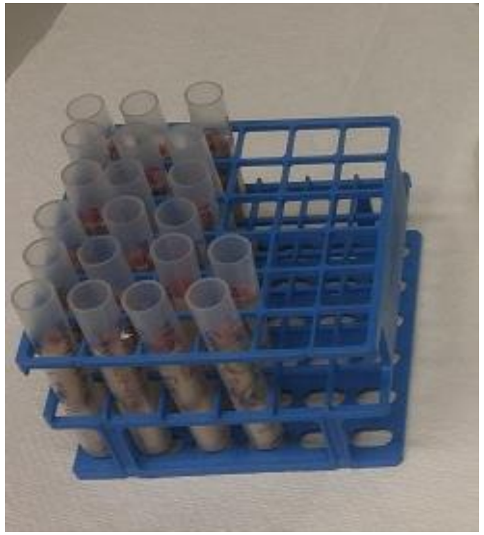


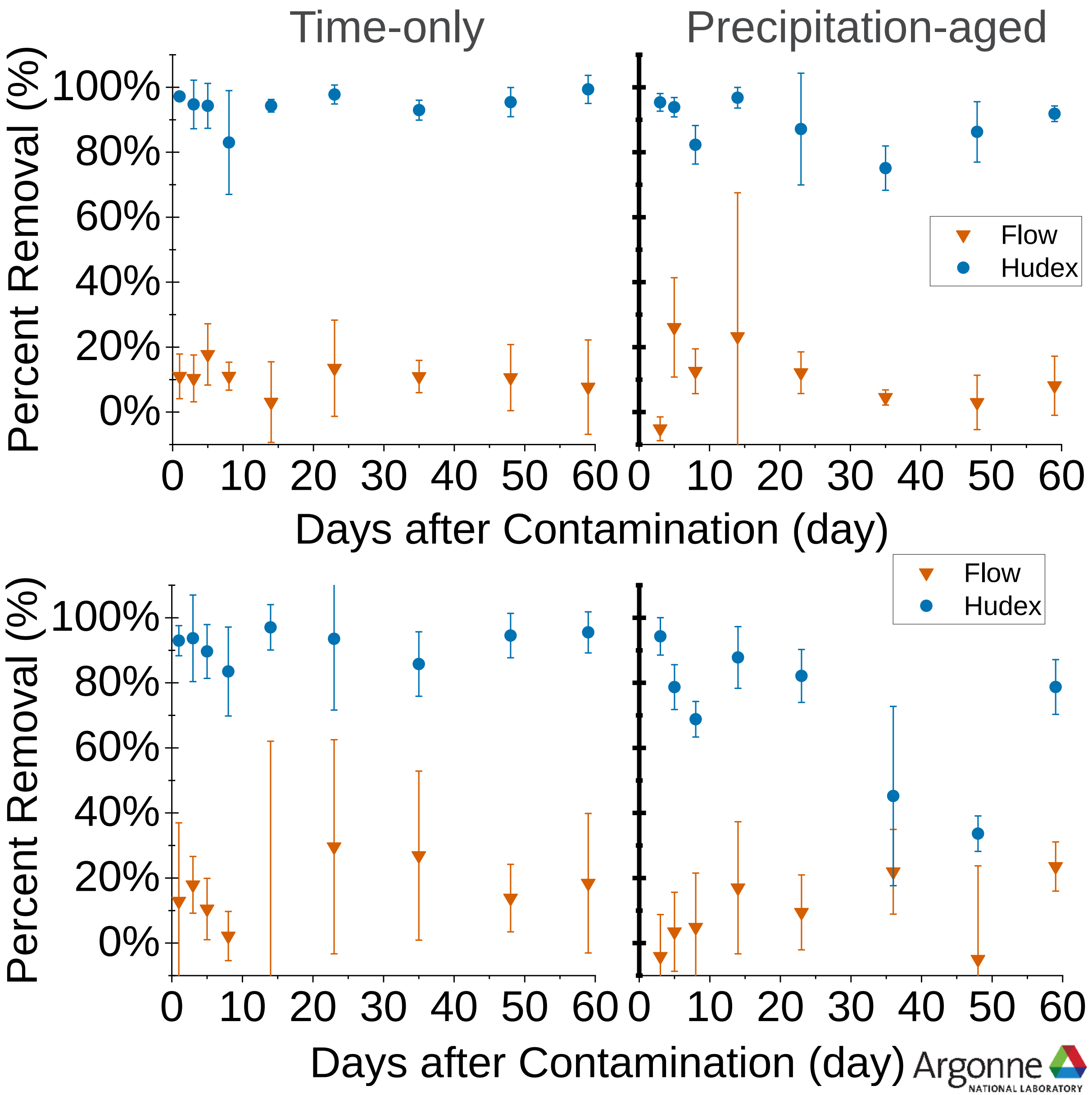
Figure 4. Example gamma tubes filled with sand paper and removed coupon surface material.

PARTICLE DECONTAMINATION

- Pressure washing was effective at removing particles
- The concrete surface roughness likely limited particle removal during flow tests
- Percent removals were independent of aging time

2 µm particles

0.5 µm particles



CESIUM DECONTAMINATION

- Percent removal significantly dropped within 10 days of contamination for flow tests
- Pressure washing was ineffective at removing cesium in this study
  – Minimal surface ablation

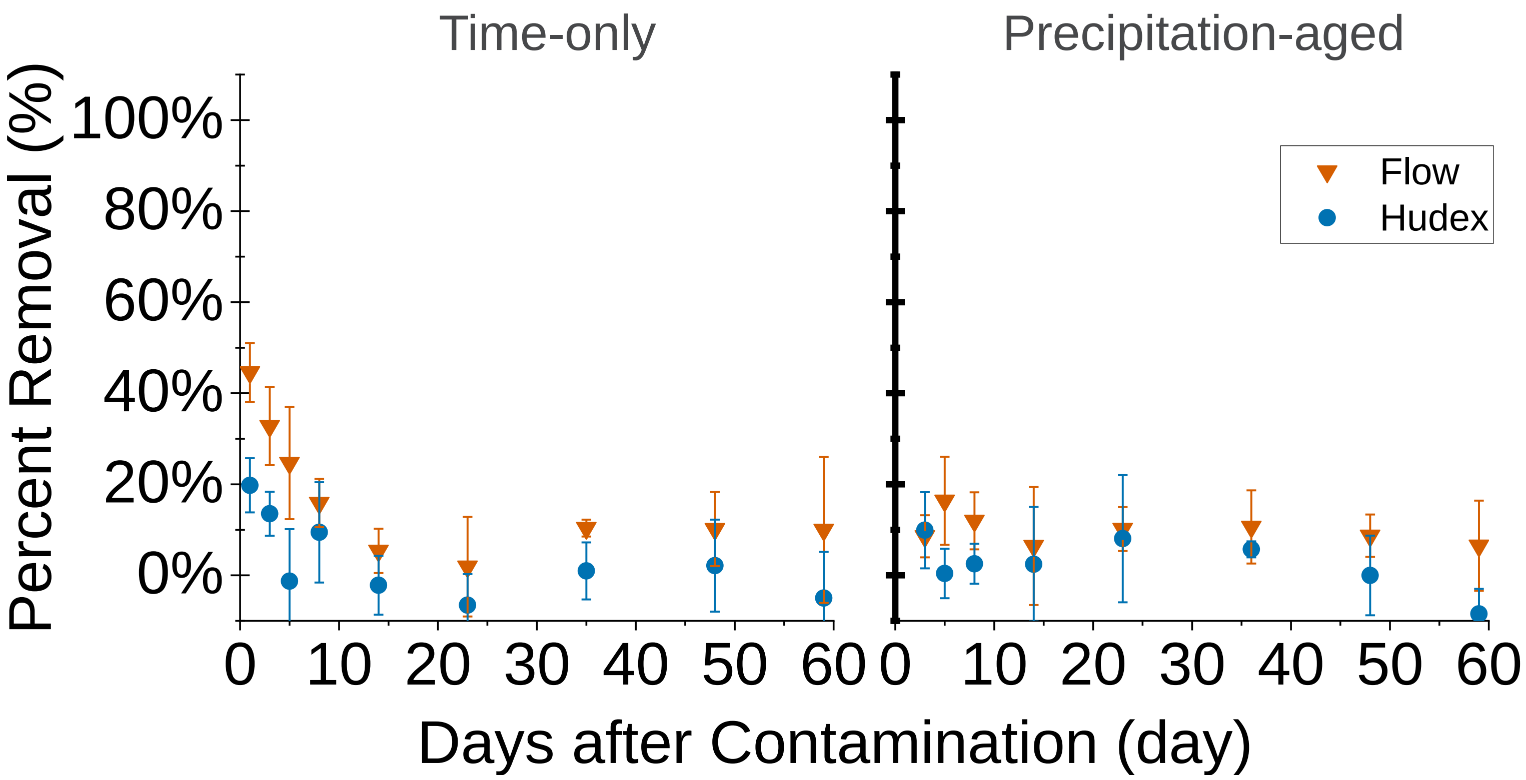
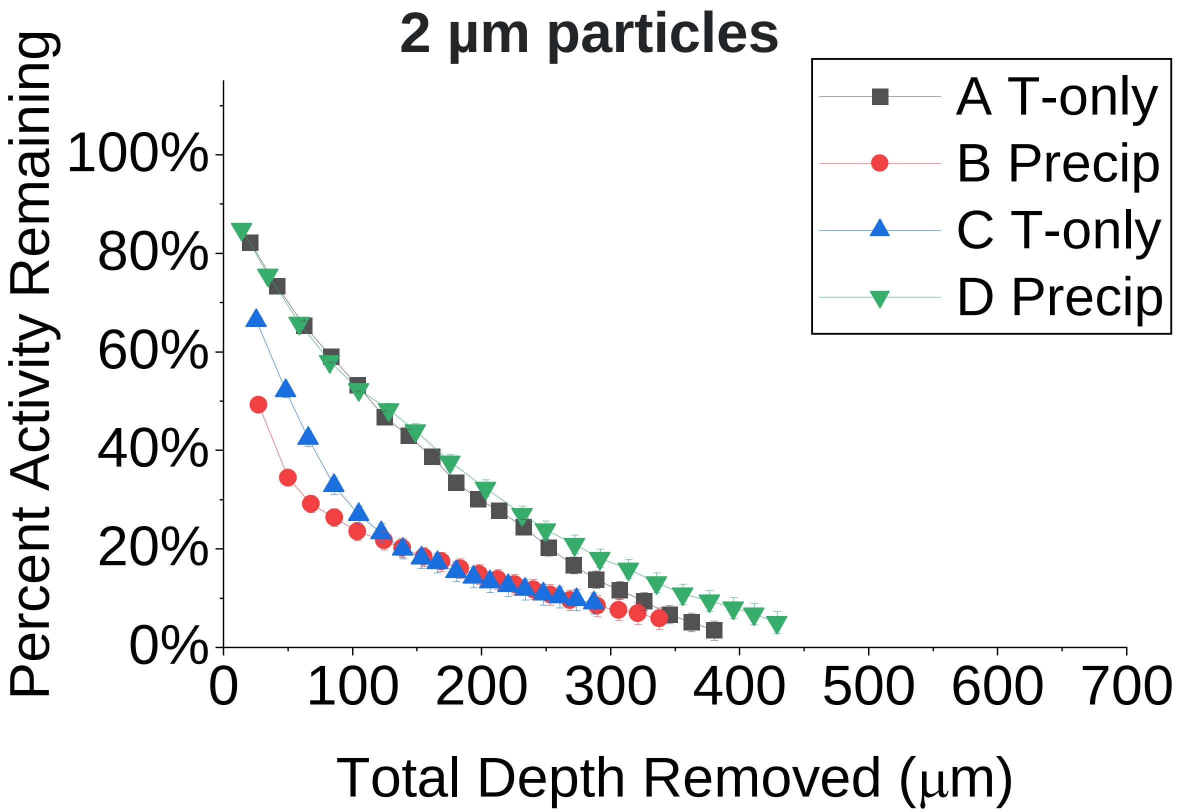


Figure 5. Percent removal vs. contamination aging time for cesium aged between 1 and 59 days.

PARTICLE DEPTH PROFILES

Surface roughness effects



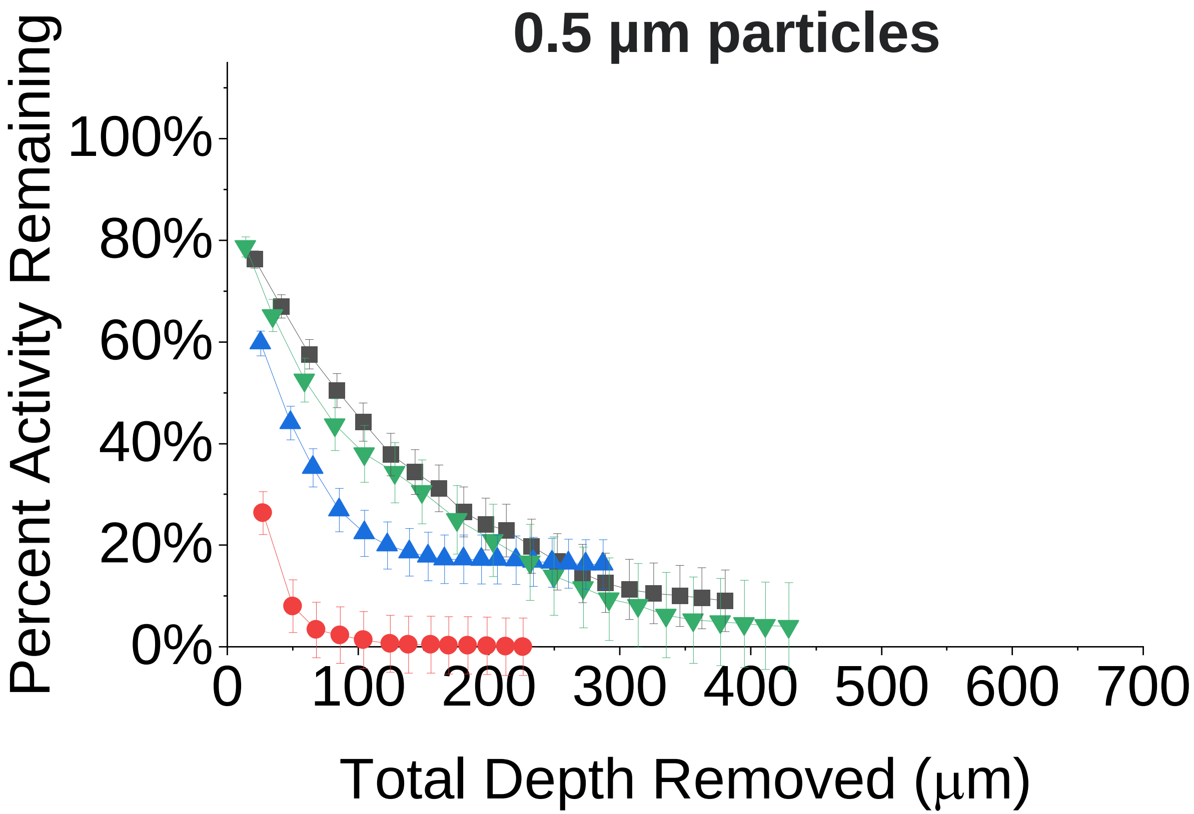


Figure 6. Percent removal vs. depth for coupons aged 35 days aged. T-only means 'time-only aged' and Precip means 'precipitation-aged'.

CESIUM DEPTH PROFILES

Surface roughness effects

- Coupons A and D appear to have a larger surface roughness range than coupons B and C
- As with the particles, smooth surfaces led to more activity being removed during initial layers

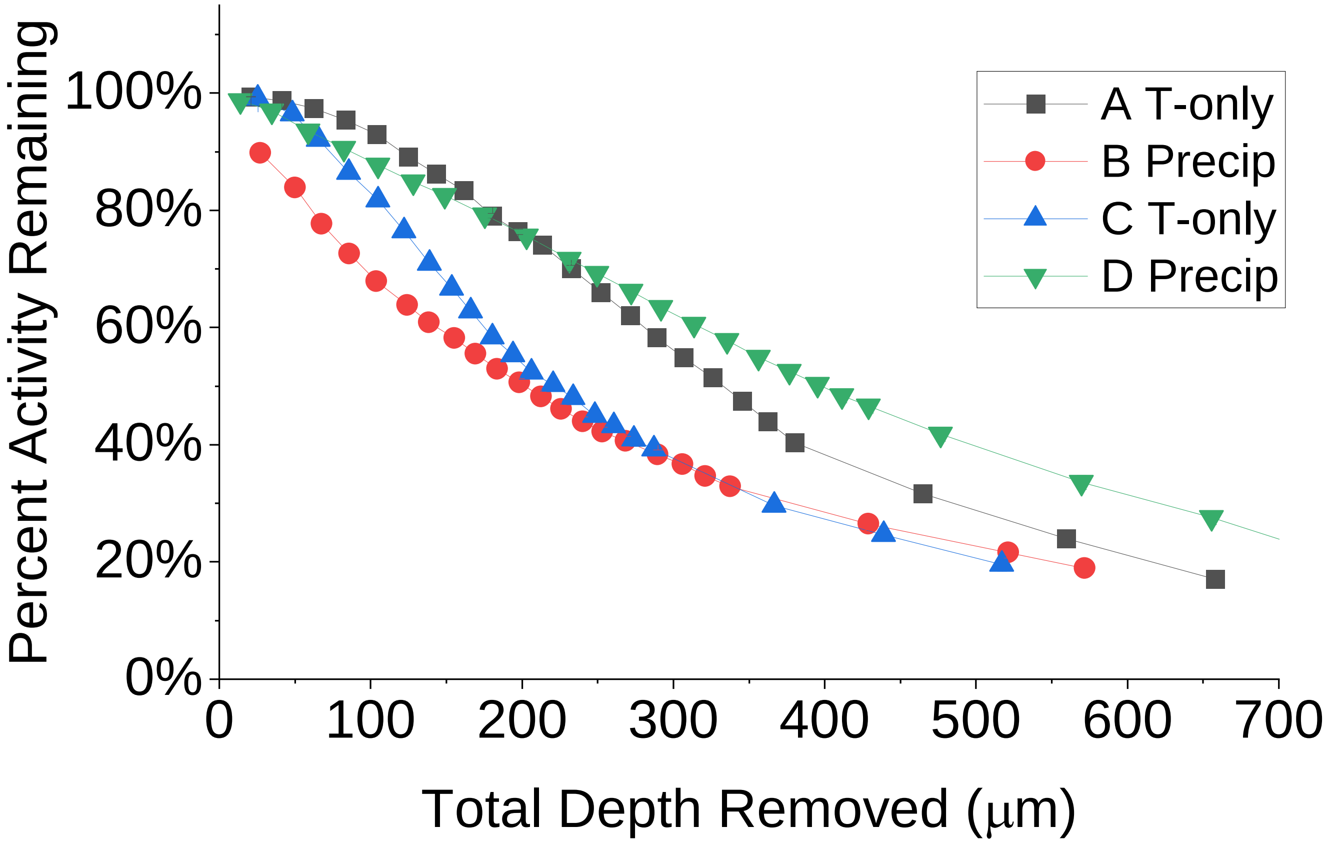
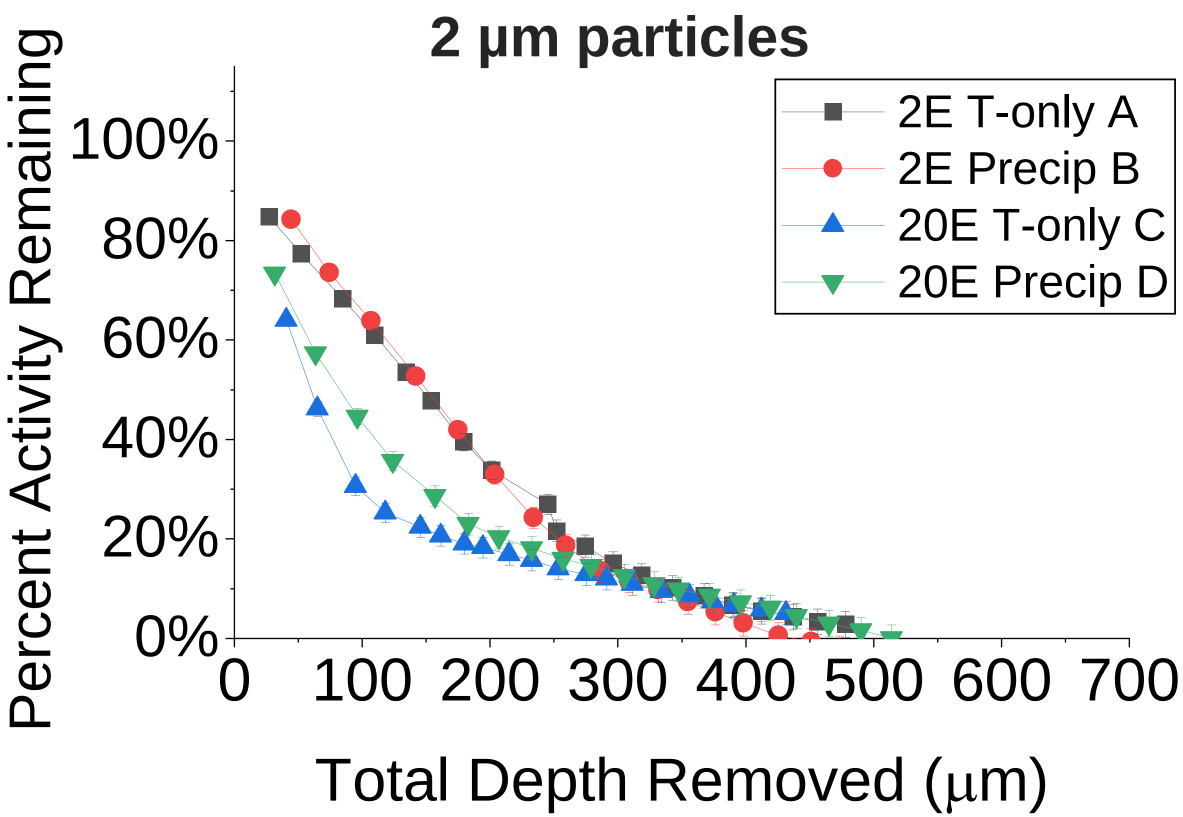


Figure 7. Percent removal vs. depth for cesium aged 35 days with or without precipitation events.

PARTICLE DEPTH PROFILES

Effects of aging method and aging time



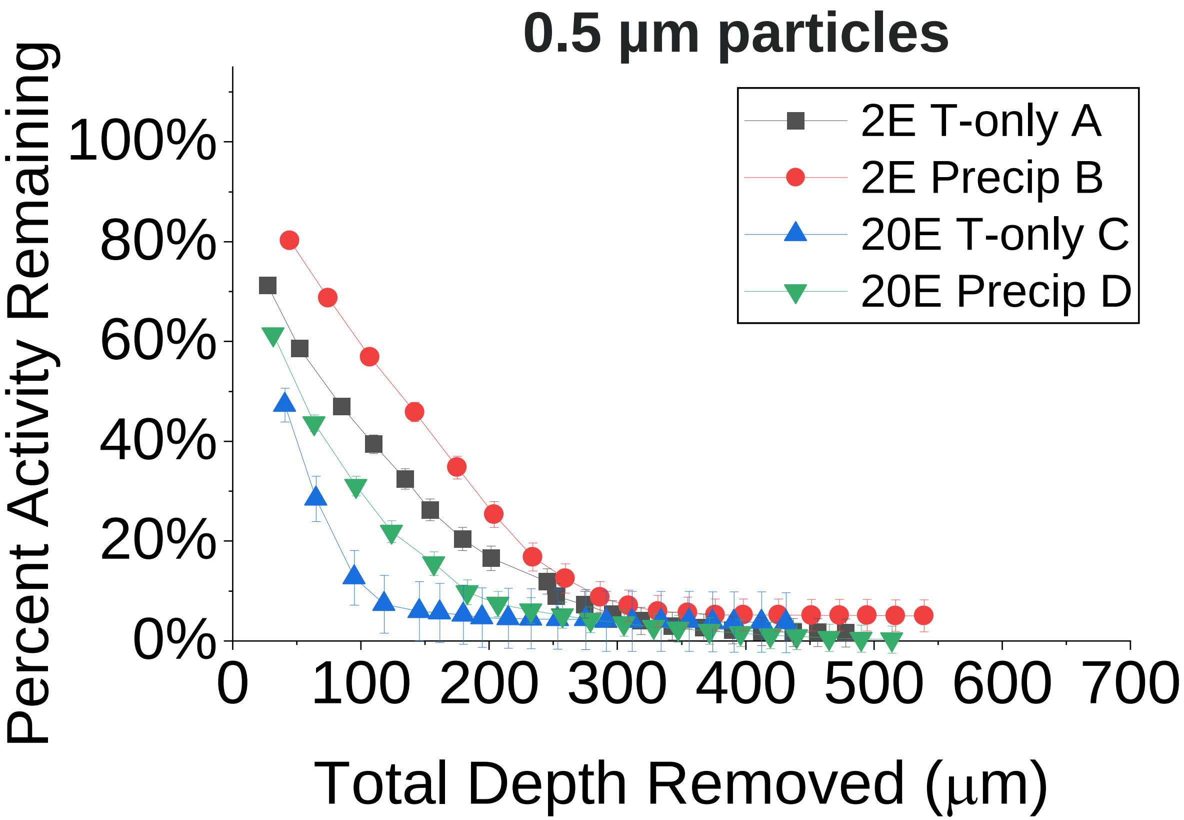


Figure 8. Percent removal vs. depth for coupons aged either 5 days (2E) or 59 days (20E). A – D are sample identifiers.

CESIUM DEPTH PROFILES

Aging time and method comparison

- Clear difference between the 2-Event and 20-Event profiles using the same aging method.
- Majority of cesium was within the first 1 mm of the subsurface even after 2 months of aging with precipitation events

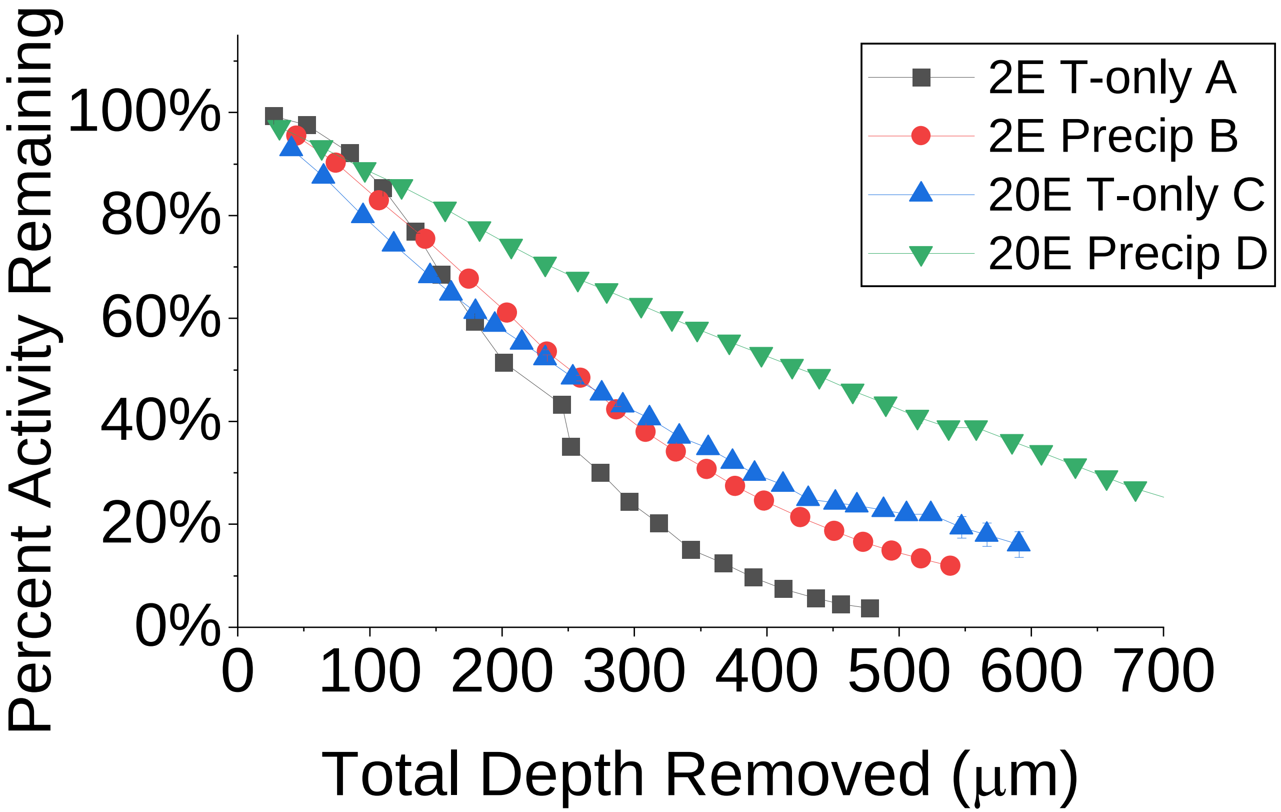


Figure 9. Percent removal vs. depth for cesium aged either 5 days (2E) or 59 days (20E).

CONCLUSIONS

- Particles can be removed by pressure-washing independent of aging time or method
- Flow tests were ineffective at removing particles, likely because of particle settling in surface depressions and insufficient flow velocity
- Observed cesium removals were for both decontamination methods were very low after 10 days of contamination aging.
- The majority of cesium was found within the first millimeter of the subsurface after two months of aging with precipitation events

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