The effects of dirtied surfaces on contaminant retention and decontaminant performance

Janlyn H. Eikenberg, John P. Davies, Brent A. Mantooth[1]
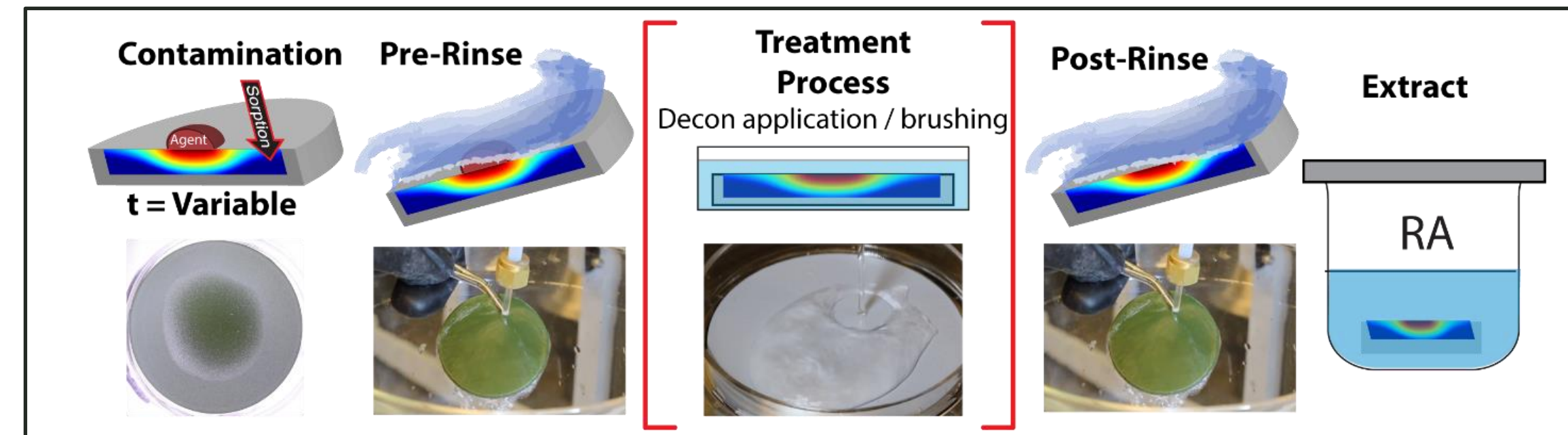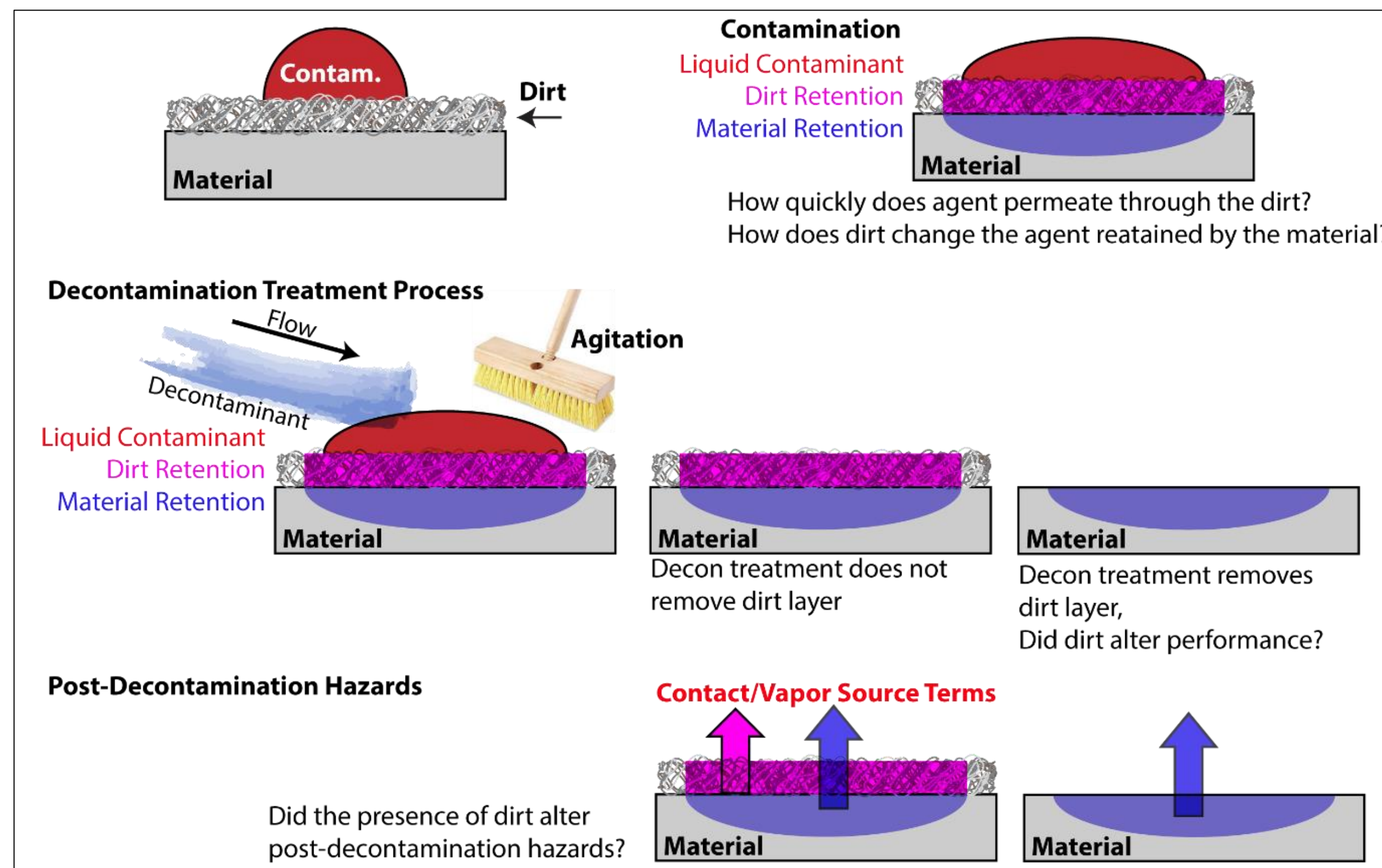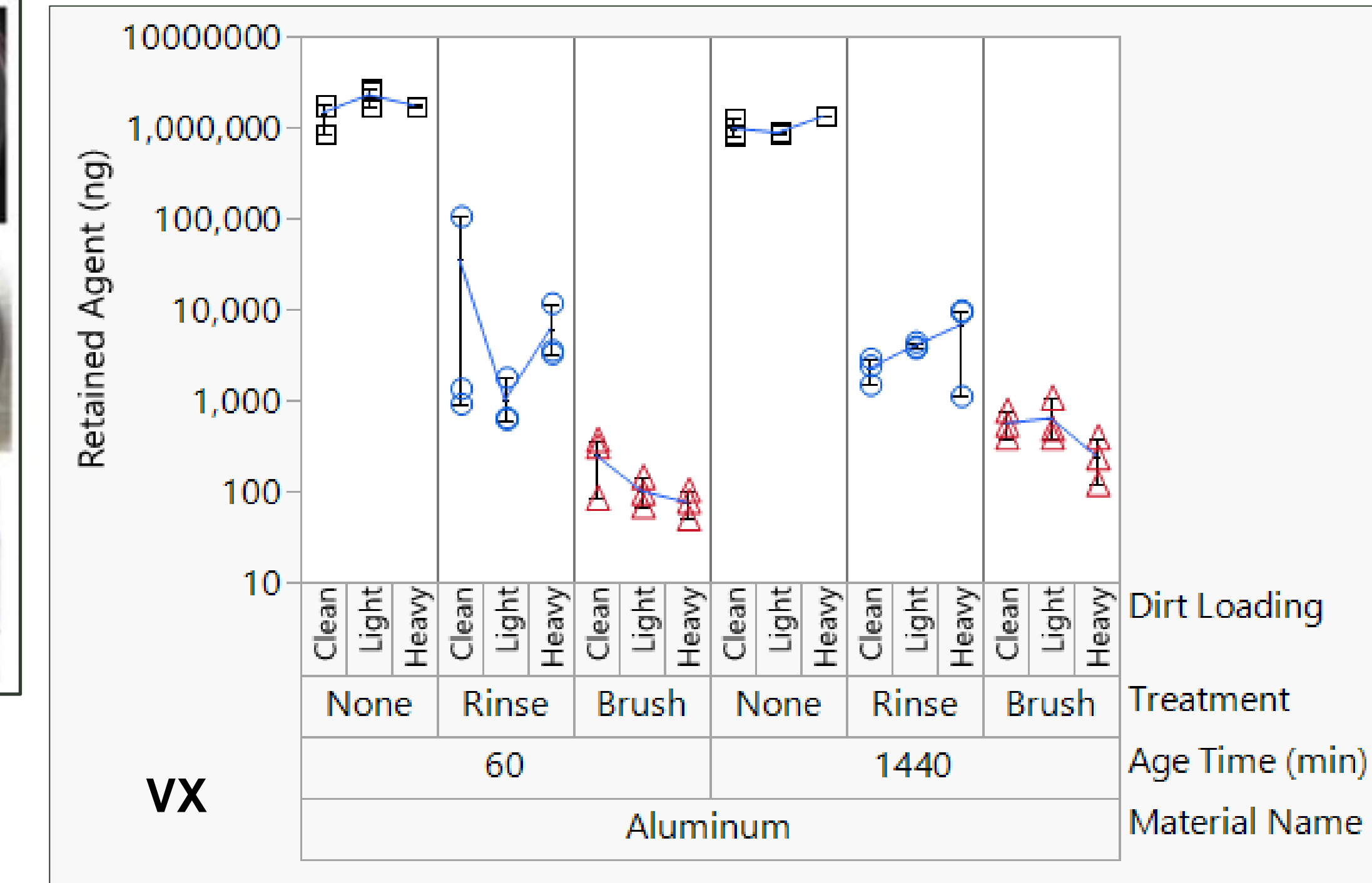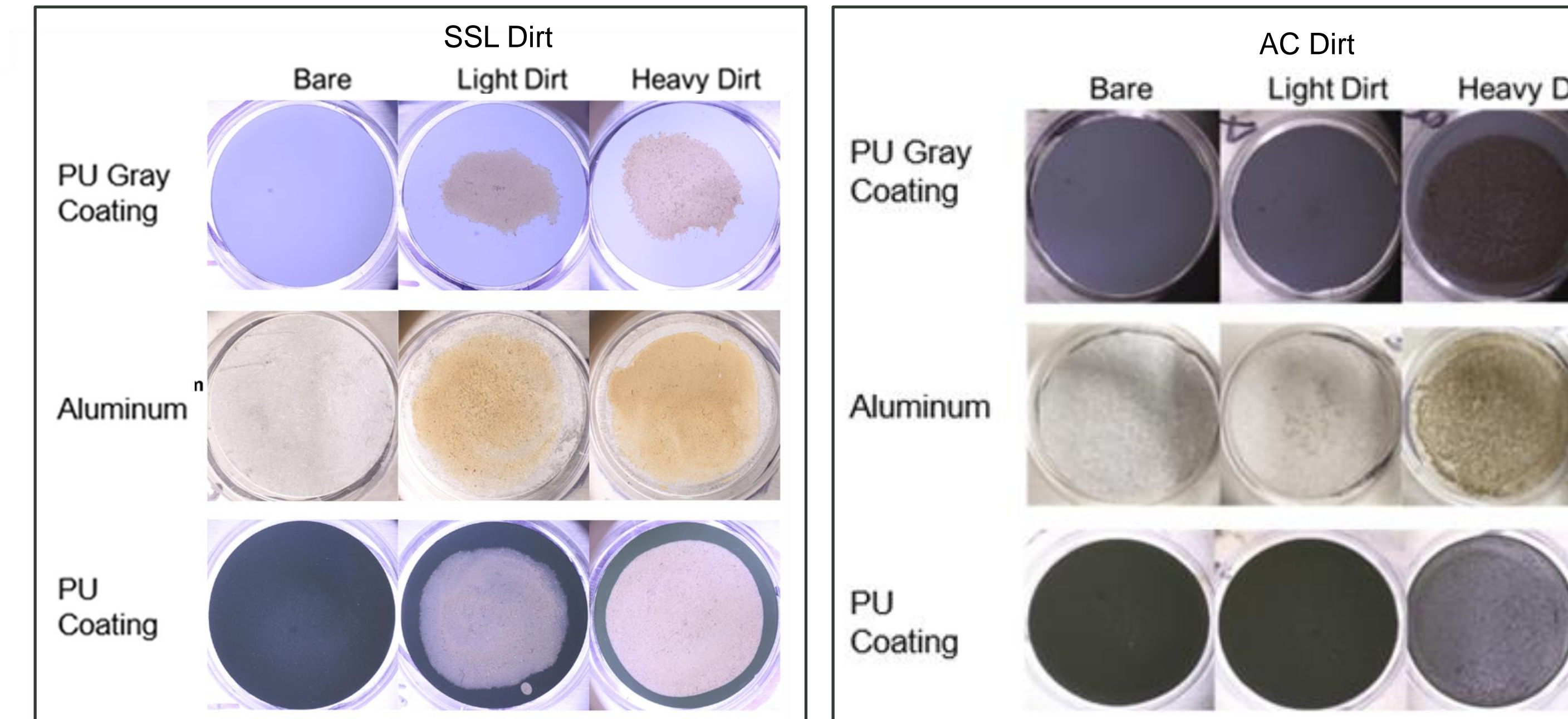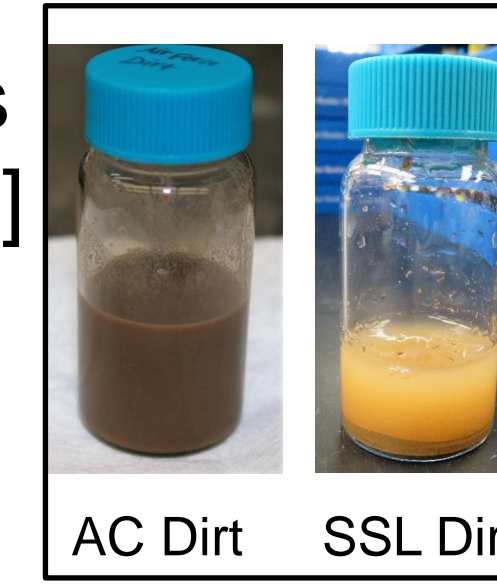[1]U.S. Army Combat Capabilities Development Command Chemical Biological Center, Aberdeen Proving Ground, MD

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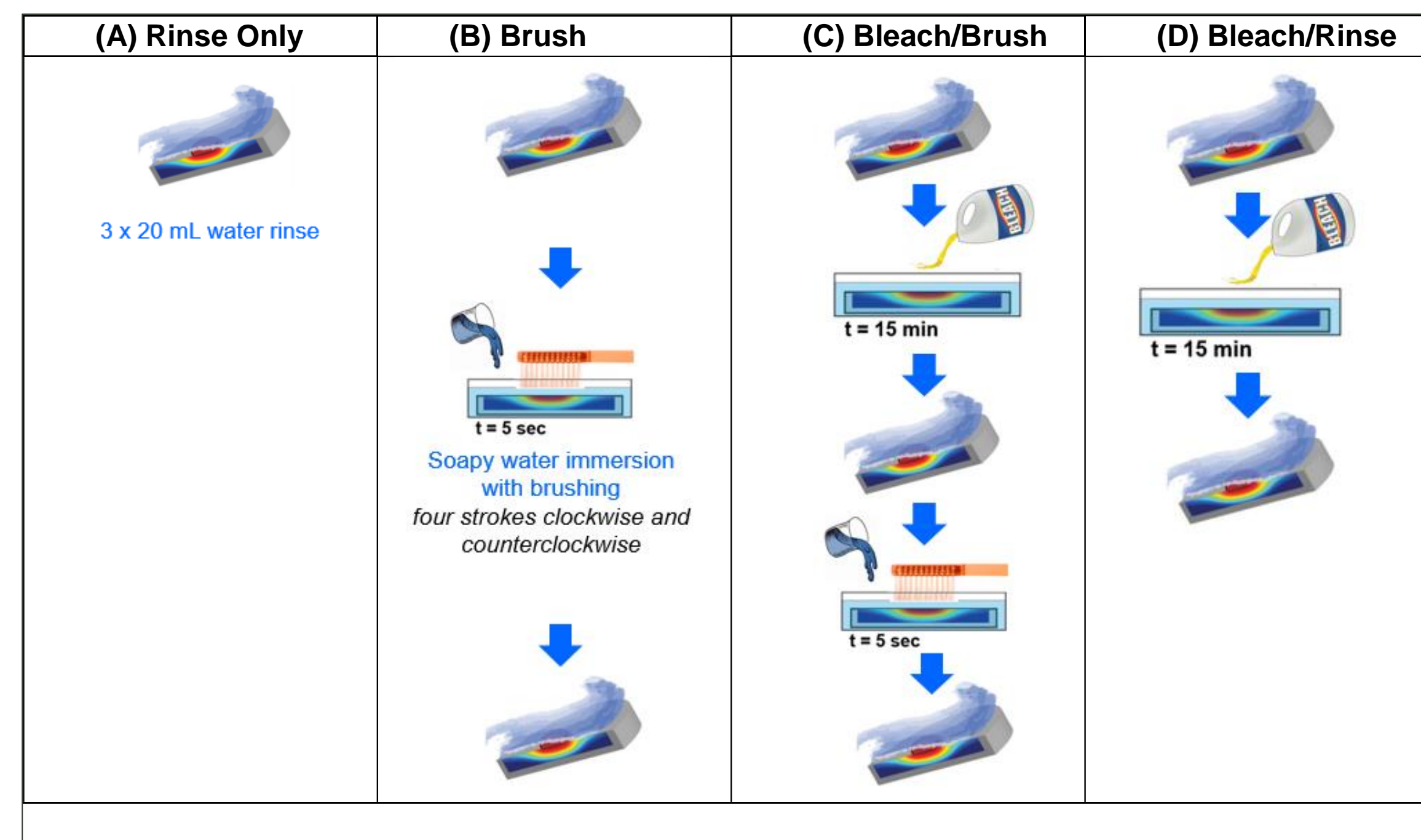
Background:

There is a need to understand how decontamination technologies will work on real assets in the field. The ability of a decontaminant to remove agent is highly dependent on the agent distribution on the asset, which determines accessibility of the decontaminant treatment to the agent. In this study, we explored how dirt covered surfaces impact this agent distribution and the subsequent decontamination process. "Where is the agent in the end?" Do dirty surfaces pose a more difficult decontamination challenge, one that should be accounted for in laboratory studies when evaluating decontamination technologies?

How quickly does agent permeate through the dirt? How does dirt change the agent retained by the material?

Decon treatment does not remove dirt layer

Decon treatment removes dirt layer, Did dirt alter performance?

Did the presence of dirt alter post-decontamination hazards?

Analysis focuses on Retained Agent (RA) of the material as lower RA indicates lower potential exposure to personnel interacting with reissued asset materials

Materials, Chemicals, Methods

- Aluminum (impermeable), Green, and Grey PU coatings
- Sassafras Sandy Loam (SSL) [sandy environmental soil] and Aircraft (AC) [greasy/sooty] soil used to coat the materials with light or heavy loading levels.
- Chemical warfare agents: HD, VX
- T=20-25 °C, RH=~50%
- Samples underwent one of four treatment procedures (shown below) or a none (positive control) condition, all resulting in a retained agent (RA) in the material measurement

AC Dirt   SSL Dirt

Treatment Processes

(A) Rinse Only — 3 x 20 mL water rinse
(B) Brush — Soapy water immersion with brushing four strokes clockwise and counterclockwise
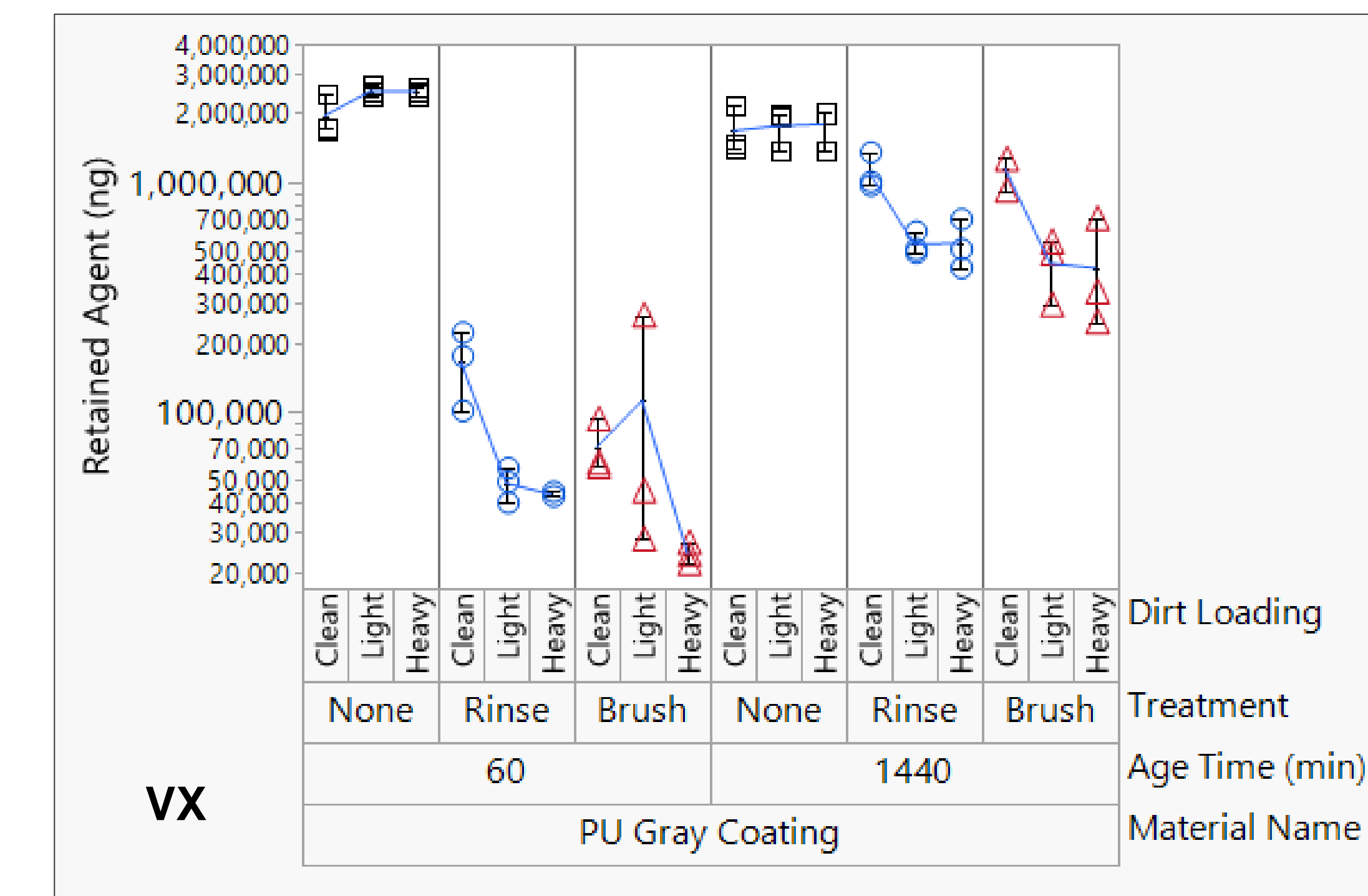(C) Bleach/Brush
(D) Bleach/Rinse

Results/Observations

- Clean, untreated materials retained the most contaminant.
- Soiled materials tended to retain equal or lesser quantities of RA compared to clean materials
- Dirt may provide a protective layer that is removed by decontamination and minimizes agent sorption into the underlying materials providing lower material RA
- RA increases as the contaminant age time increases for the PU coated materials
- Similar trends were observed across both VX and HD as well as across the two dirt types, SSL and AC. (Data shown only for VX)
- Results were used in a design of experiment (DOE) model to answer the questions; *"what influence does the presence of dirt or the type of dirt have on the log difference (LD) compared to a clean material response?"* and "I*s there a change in decontamination performance due to dirt that is specific to certain agents, certain decontamination treatments, or certain material substrates?*"

Conclusions

- Highest RA (higher exposure potential) were observed for clean surfaces
- Presence of dirt seems to provide lower RA, potentially by the dirt layer inhibiting agent transport and sorption to the material
- From the DOE model considering soil parameters, and treatment types, the treatment process is more influential than the soil related parameters
- Should dirtied surfaces be considered in test and evaluation efforts?
  - No, because while the dirt may affect the distribution of agent within the system, ultimately, the process that removes the dirt and interacts with the underlying surface has the greatest impact on RA