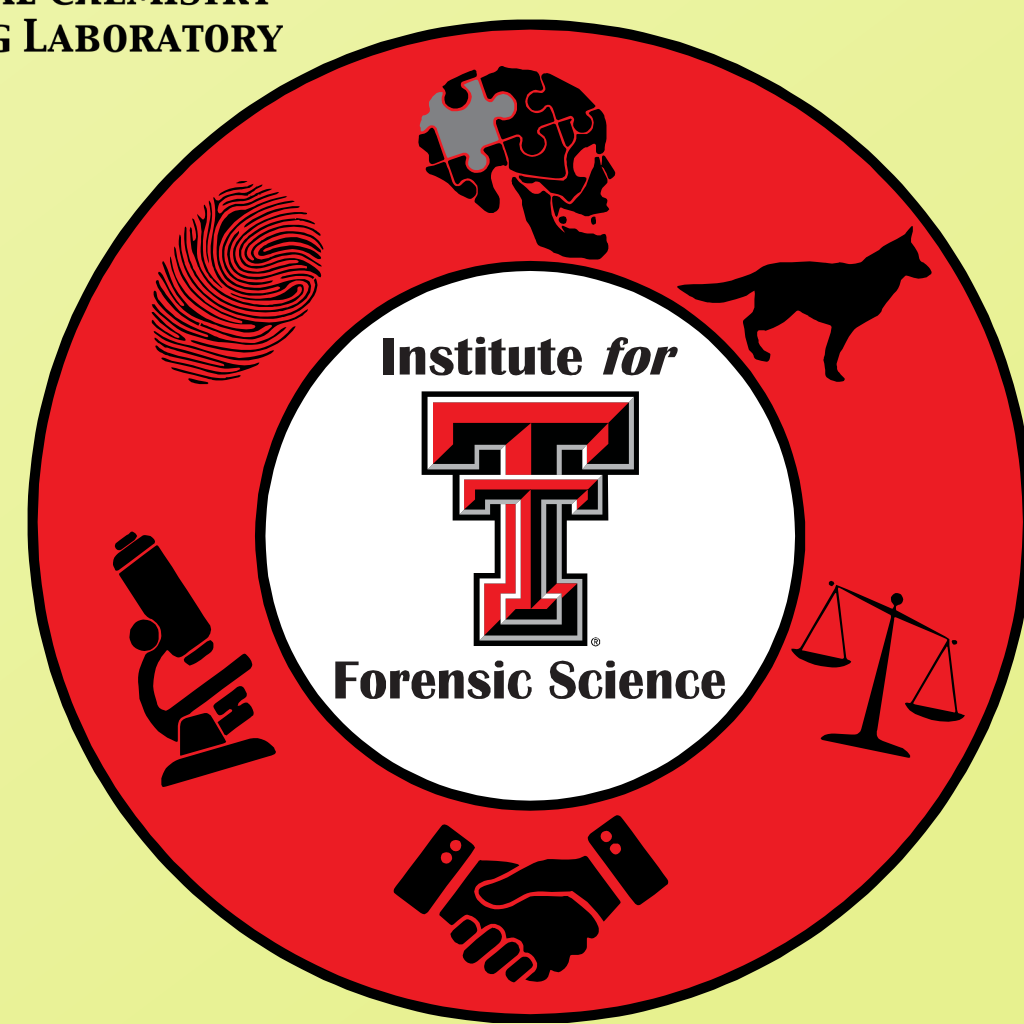




What's that Lingering Smell? Evaluation of Residual Odor Volatiles in Colombian Territory.

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Abstract

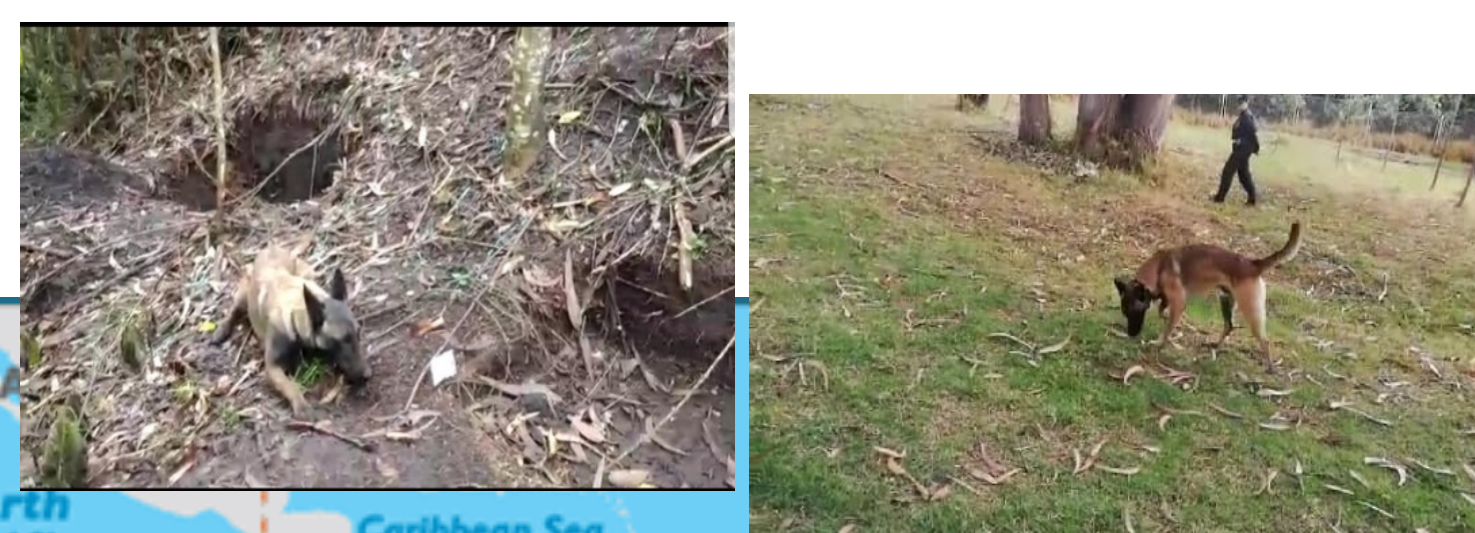
There is limited scientific research into how residual decomposition volatile organic compounds change over time, with even less research into how the compounds change as a function of contact time between the decomposing substrate and the decomposition environment. The purpose of this study was to monitor abundances of the target odor vapors emanating from the soil after removal of decomposing human analogues (sus Scrofa animal model). This project is part of an ongoing collaboration with the Colombian National Police, School for Canine Handling and Training. One of Colombia's law enforcement problems lies in the detection of mass graves of missing or unrecognized bodies, created to remove any trace of crime. Thus, of crucial importance to enhance cadaver canine detection, is the understanding of the chemical composition of decomposition soil surfaces. The collection consisted of pigs decomposing for a period of 24 hours, 72 hours, 120 hours and 30 days, then removing the pig and sampling the soil. Instrumental analysis utilized Divinylbenzene/Carbon/Polydimethylsiloxane (DVB/CAR/PDMS) coated Solid Phase-Microextraction (SPME) fibers that were injected into a Gas Chromatography-mass Spectrometry (GC-MS) system for the identification of extracted soil headspace odor volatiles of target decomposition odors. The soil samples were taken in 10mL glass vials, shipped on dry ice, and allowed a period of 24 hours for headspace equilibration and then extracted via SPME methodology. Weather conditions such as temperature and humidity were recorded, as well as the pH and moisture content of the soil matrix. During each sample extraction, at each of the four intervals, abundance, and type of target volatiles were analyzed. Each interval exhibited distinct odor profiles depending on the surface contact time of the decomposing odor source before removal of the pig. This study has heightened the understanding of how residual decomposition odor changes over a period of time.

Introduction

This study examines the residual odors left in soil by decomposition to determine if human remain detecting (HRD) dogs can alert long *after the remains have been removed* from a grave. The purpose of this study is to monitor and provide abundances of target decomposition odor vapors *emanating from the soil after removal of decomposing human analogues* (sus Scrofa) at different contact time intervals.

Instead of determining the VOCs created by decomposing tissue and remains, this experiment endeavors to catalogue the *residual odors left by decomposition after remains are removed*. Finding unidentified remains in Colombia is a problem routinely faced by forensic investigators. In 2019, Colombia averaged **32.8 homicides a day**, many of these crimes have not been solved due to a lack in material evidence from crime scenes. By establishing how decomposition residual odor changes over time, HRD dogs will be able to identify potential dump sites or deposition locations during a criminal investigation.

Canine alert, but no remains? If HRD canines alert and signal a decomposition odor target, but there are not any remains, this *signals that the odors of decomposition remain in the soil despite the remains being removed*. Since the residual odors would not depend on the presence of the cadaver, material evidence can be collected in cases where previous cases would have ended.



Degrees of Impact:
This is the *first study* to examine the odor left by decomposed animal remains in soil samples from Colombia. This provides *novel data* for forensic investigators in Colombia to use during search recovery operations or to find potential clandestine mass grave sites.

References

- [1] Moen, John. "World Map." *World Atlas - Maps, Geography, Travel*, 12 July 2016, www.worldatlas.com/webimage/countrys/samerica/co.htm.
- [2] Perrault, Katelynn A., et al. "Detection of Decomposition Volatile Organic Compounds in Soil Following Removal of Remains from a Surface Deposition Site." *Forensic Science, Medicine, and Pathology*, vol. 11, no. 3, 2015, pp. 376–387., doi:10.1007/s12024-015-9693-5.
- [3] Raymer, Jennifer L. 2019. *Electronic Theses and Dissertations*, <https://ttu-ir.tdl.org/handle/2346/85032>.

Methods

Collection:

- ❑ The study took place at the Colombia National Police Canine & Handler Training Facility in Bogota, Colombia.
- ❑ Pig carcasses were left on the ground for 48 hours and 72 hours, respectively. Pigs were 4 months old and had weights ranging between 74-80 kg.
- ❑ After these two contact times, ground soil samples were collected after remains removal.
- ❑ There were a total of two contact-times evaluated, each one made up of three cages. Each box was sampled at each of the time periods and the soil was taken from under the pig's head, median and tail end.
- ❑ There was a blank box to test for background odors.
- ❑ Soil samples were then packaged in dry ice and sent to the Institute for Forensic Science for instrumental analysis.



Instrumental Analysis:

- ❑ Analysis occurred by injection of headspace SPME fiber through septum after a 24-hour equilibrium period for 24-hour exposure to soil. Extraction of the VOCs was accelerated by placing the sampling apparatus on a hot plate at 40° Celsius. GC/MS analysis examined all the compounds released.

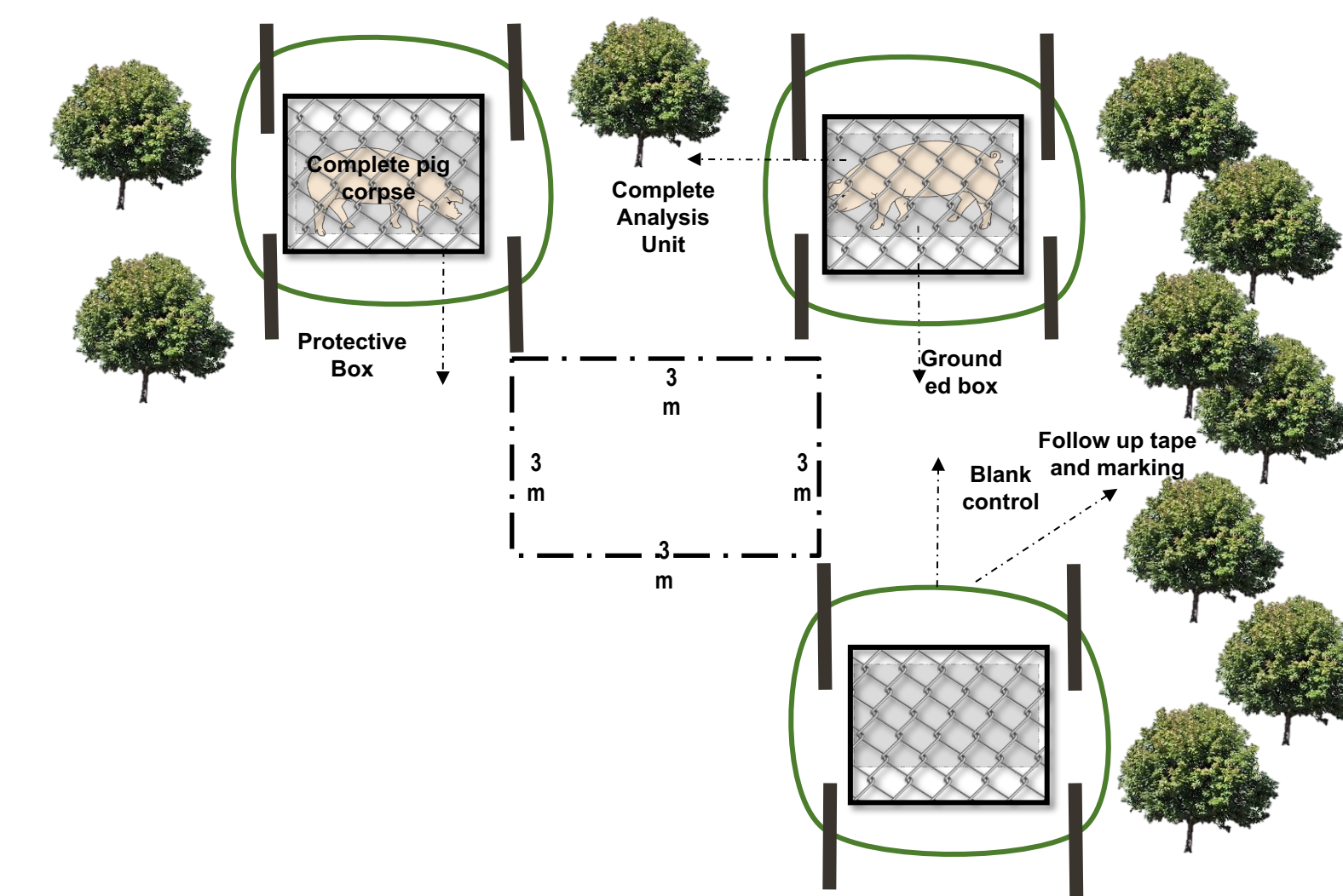


Figure 1. Sampling diagram showing one of two sampling zones.

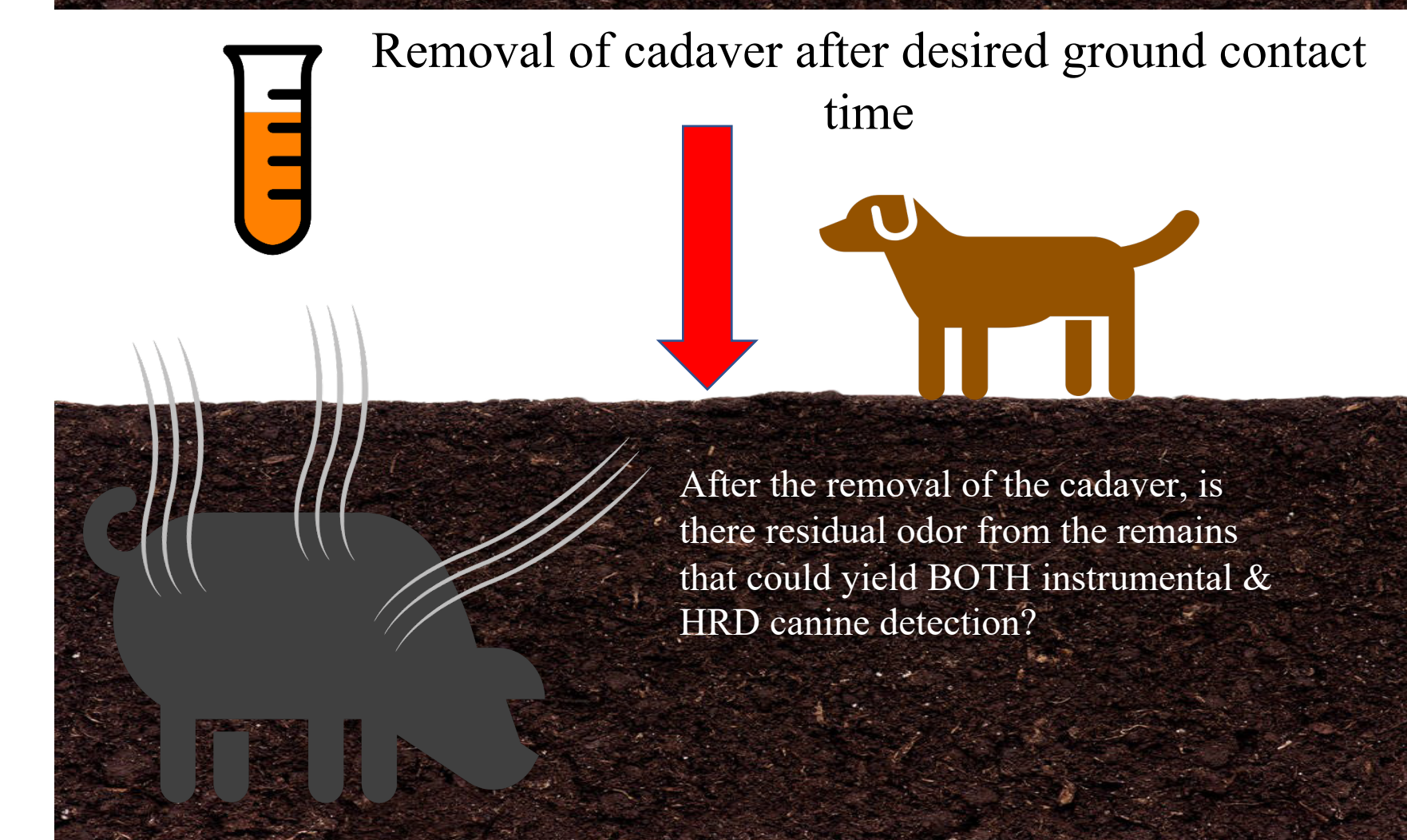
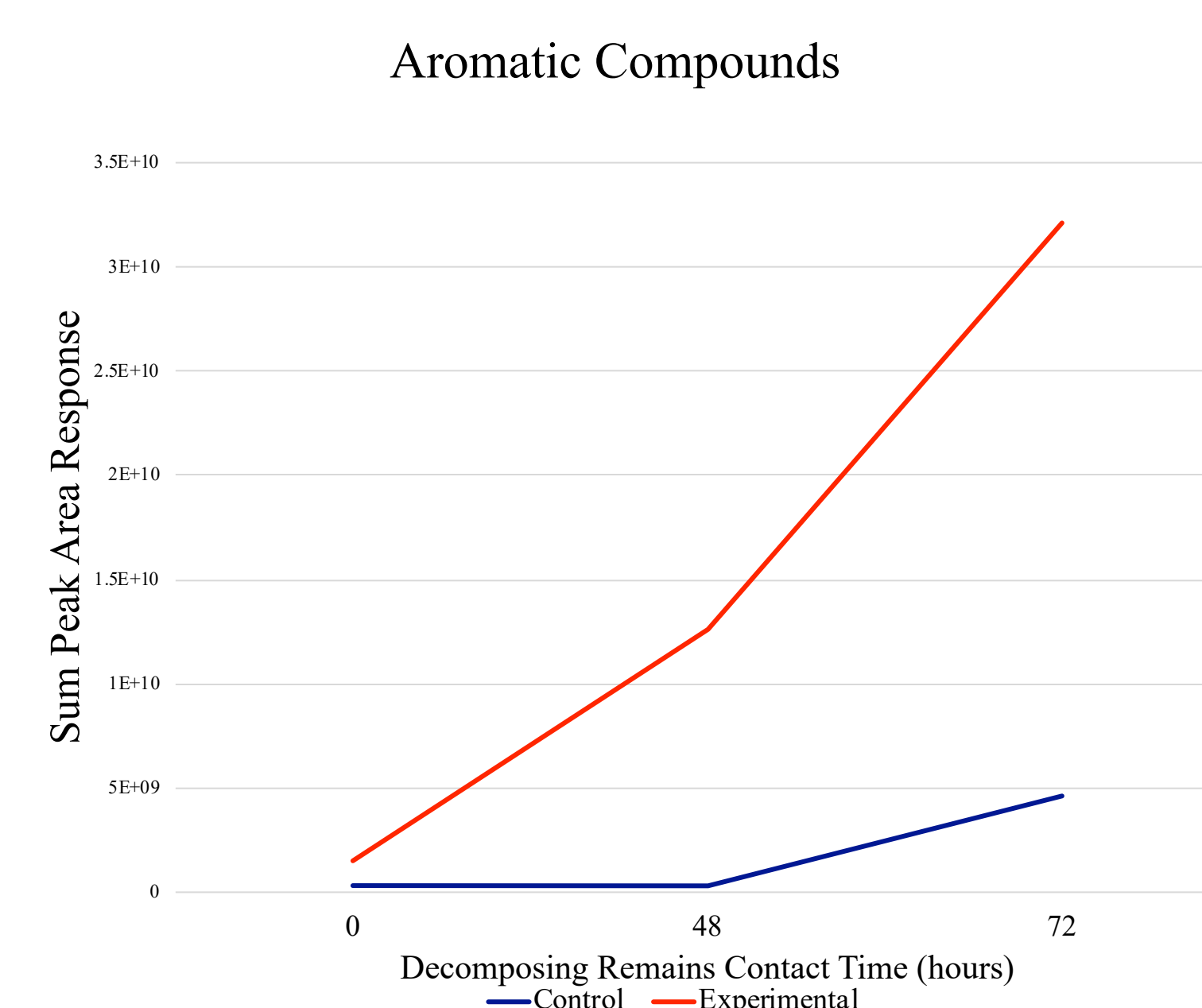
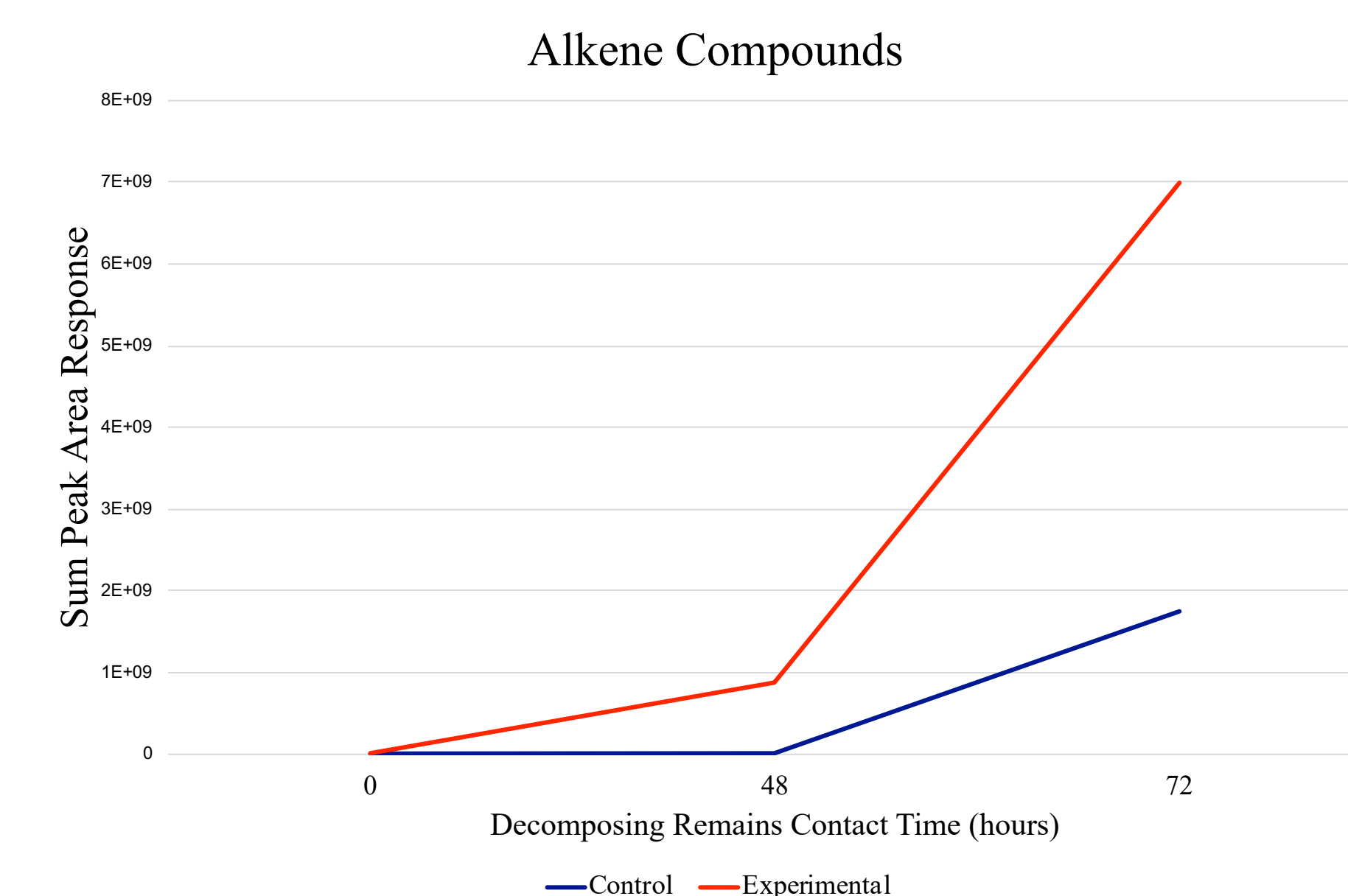


Figure 2. Diagram explaining residual odors

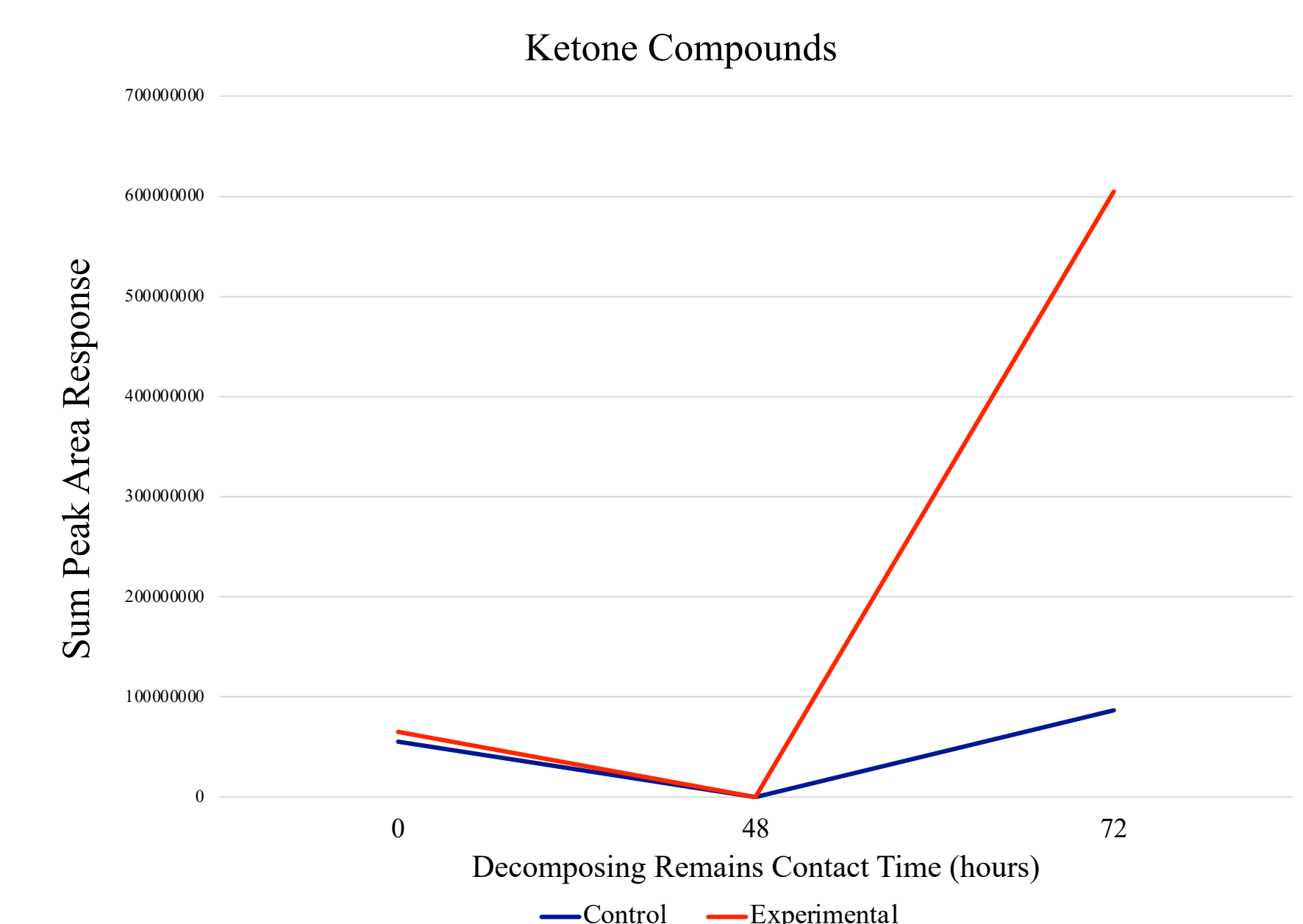
Results



Common Aromatic Compounds Include	
Toluene	
P-Xylene	
Benzene, 1,3-dimethyl-	
Ethylbenzene	
Benzene, 1,2,4,5-tetramethyl-	



Common Alkene Compounds Include	
1H-Cycloprop[e]janzulene, 1a,2,3,4,4a,5,6,7b-octahydro-1,1,4,7-tetramethyl-, [1aR-(1a.alpha.,4.alpha.,4a.beta.,7b.alpha.)]-	
Aromandendrene	
Tricyclo[5.4.0.0(2,8)]undec-9-ene, 2,6,6,9-tetramethyl-, (1R,2S,7R,8R)-	
(-)-aristolene	
Longifolene	



Common Ketone Compounds Include	
Androstan-17-one, 3-(formyloxy)-11-hydroxy-, (3.alpha.,5.alpha.,11.beta.)-	
Fenchone	
Bicyclo[3.1.1]heptan-3-one, 2,6,6-trimethyl-, (1.alpha.,2.alpha.,5.alpha.)-	

Volatile Organic Compound (VOCs) Functional Group Trends in Soil after Exposure to decomposing remains for up to 72 hours

Conclusion

There were **185 significant compounds** that were detected with in the accepted range which was greater than or equal to 90%. In order to be considered significant, the compound had to be detected in all three samples of a single pig. A high number of Alkenes were present during the study and this is consistent with the results of previous studies done by Perrault et al [2] and Raymer [3]. The alkenes in time 2 increased about 3 times to that of time 0 (blank soil samples). The most frequent occurring compound for times 1 and 2 is toluene. The compound most commonly associated with decomposition is sulfur containing compounds and these were determined to be present in the soil samples as well. By establishing these decomposition associated compounds we are able to show that *the soil contained these compounds even after the tissue had been removed from its presence*.