Systems for Plant Volatile Organic Compound (VOC) Analysis

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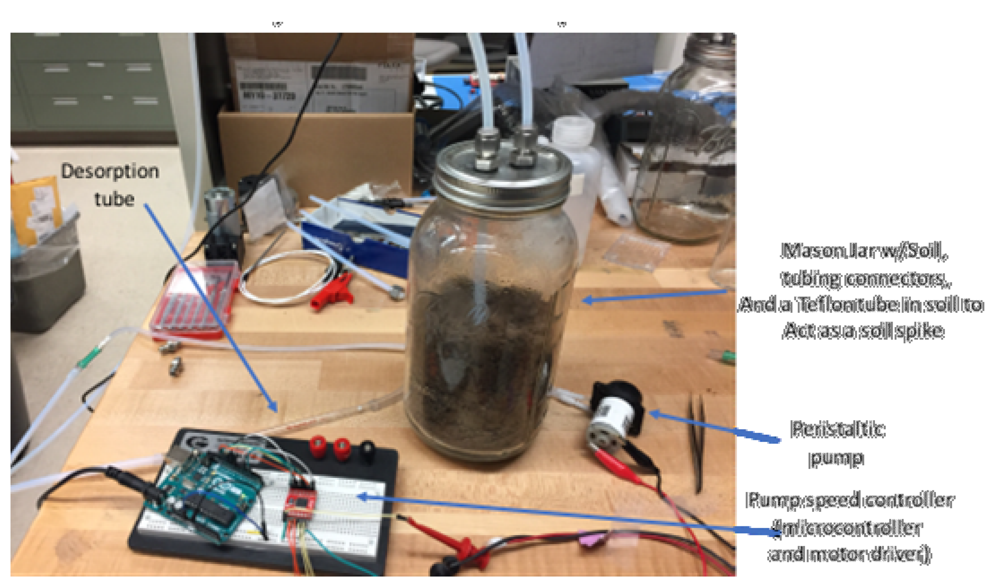
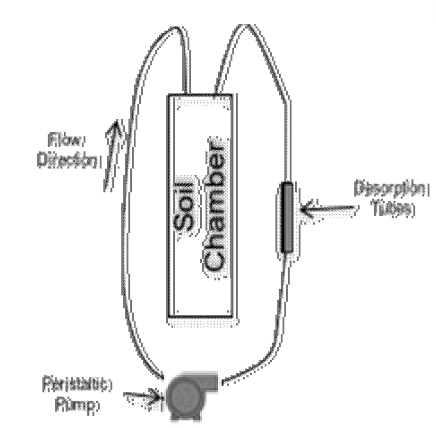
Current VOC Sampling



Recirculating System Setup

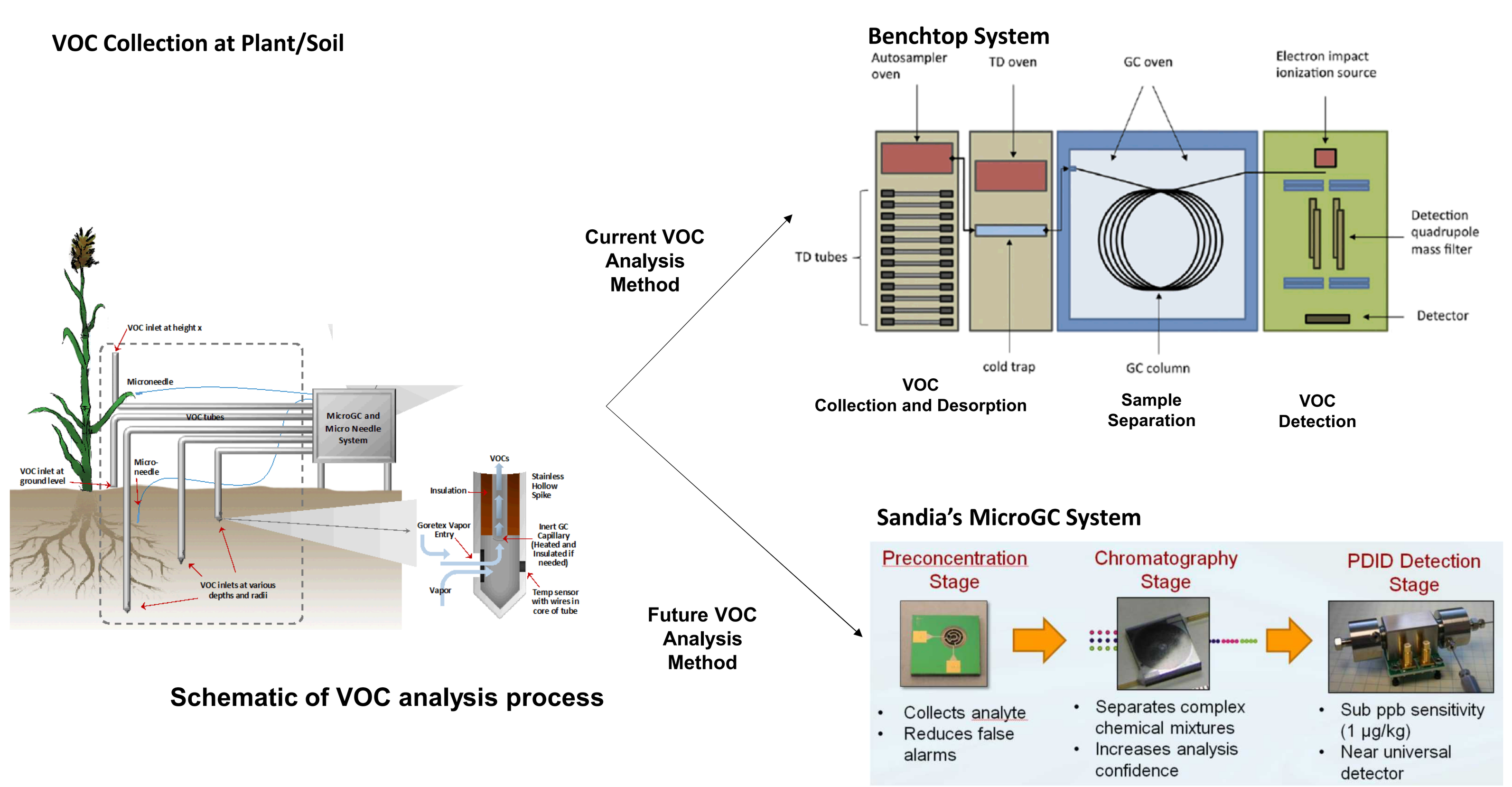
erate VOCs in response to both biotic and abiotic stressors. These compounds are central to their
obe, avian, insect, microbe) and intra species communication strategies. Their biosynthesis
make natural targets for genetic manipulation. This signaling can be harnessed to produce natural
on, such as when herbivory alarm VOCs are detected and generated by nearest neighbors.

- Recirculating collection system was created to collect VOCs on sorbent-filled desorption tubes using a peristaltic pump.
- Initial results showed little signs of a VOC profile.
- Sampling for longer intervals (24hrs vs 1hr) with recirculation improved the collection method.
- The collection system can be run in either headspace or below ground sampling configurations to mimic our soil spike prototypes.



Recirculating System Schematic

VOC Analysis with Thermal Desorption and GC/MS



Schematic of VOC analysis process

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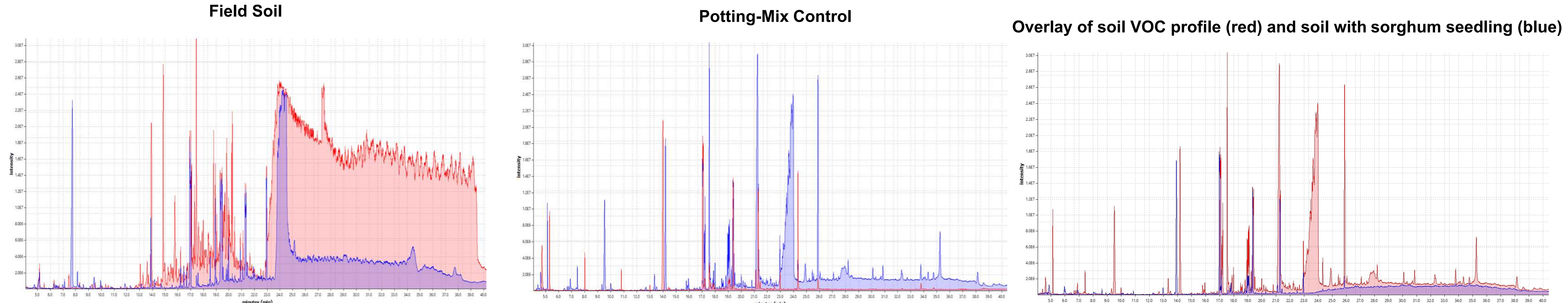
VOCs from Soil and Plants



Blue: in-soil collection Red: headspace collection

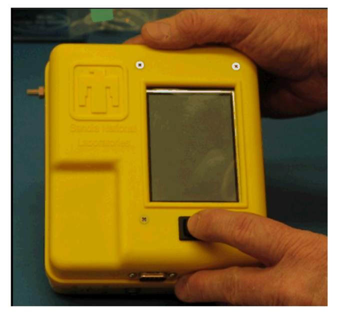
- Soil collected from the Los Lunas field site was added to the recirculating system and sampled 48 hours post rehydration with sterilized tap water.
- VOC profiles mainly consisted of hydrocarbons, some of which have been referenced in the literature as emitting from some soil types.
- Initial results run at the same conditions indicate that more VOCs were collected through the soil spike than in the headspace of the jars. 65 identified VOCs in the soil sample collection vs 31 VOCs in the headspace.
- Miracle grow samples were also tested as a positive control.

- Data processing ongoing and additional sorghum seedling samples have been collected and are in the GC/MS sample que

VOC Sensing System Concept

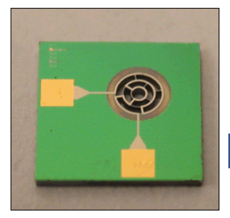
Plant VOC Sources
- Leaves
- Roots

UAV Collection

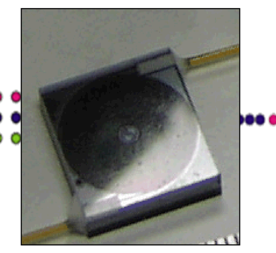


Field VOC Sensing
- Rapid results and survey of large areas
- More expensive platform and deployment costs

VOC Capture for Laboratory Analysis
- Inexpensive platform and gold standard analysis
- Use Sandia's µSamplers or conventional collection tubes



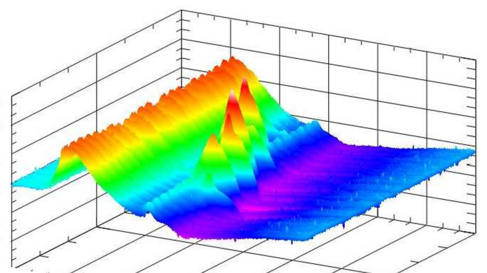
Preconcentrator Stage
- Preferentially collects VOCs from the environment.
- Reduces false alarms by rejecting interferents.



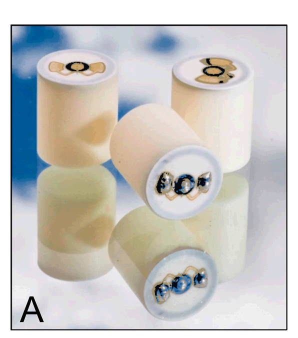
Separation Stage
- Separates complex chemical mixtures in time.
- Increases analysis confidence by allowing chemical identification.

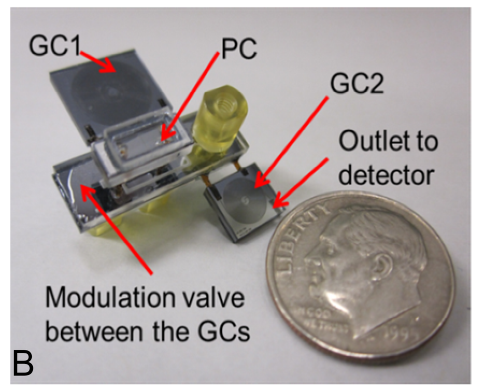
Detector Stage
- Sub ppb sensitivity

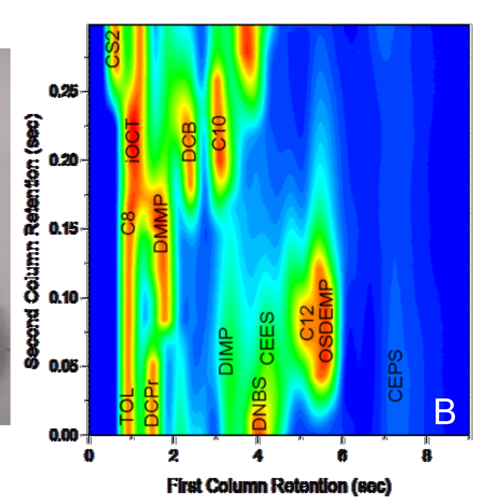
Identification of VOCs by GC/positive mode IMS



Unique Technologies from Sandia





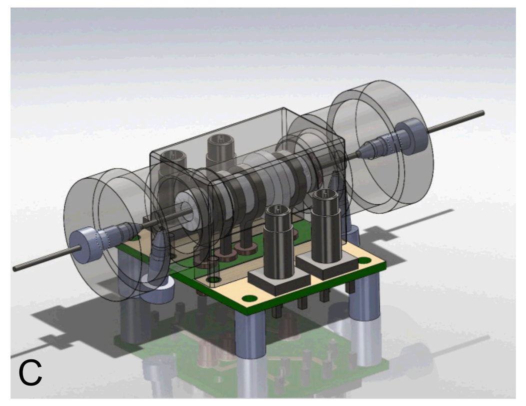


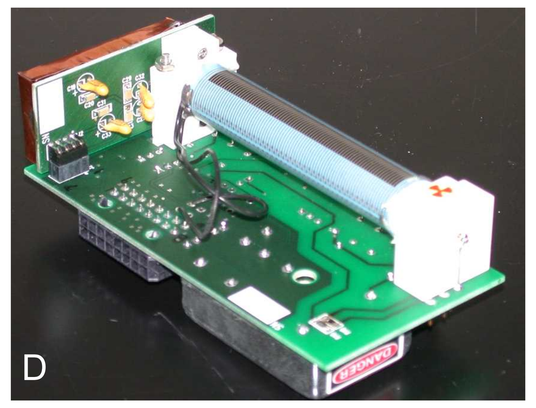
A: VOC Capture Stage- µSampler

Inert, low SWAP, and evacuated sample volumes. Captures and stores pristine environmental samples.

B: Separation Stage- Micro GCxGC

The GC channels are microfabricated in a tight circular coil on a silicon chip allowing GC1 to be 1 meter long and GC2, to be 30 cm long. At right is a two dimensional microGCxGC separation of 14 chemicals in under 10 seconds. This comprehensive separation of complex chemical mixtures requires no a priori knowledge of the target environment. Air can be used as the GC mobile phase to eliminate consumables but will result in longer separations.





C: Detector Stage- Miniature Ion Mobility Spectrometer

Sandia has developed a miniature correlation IMS system for the detection of explosive compounds. This system has seen extensive field testing and is shown to detect picogram quantities of explosive compounds. Recent testing has demonstrated the ability of this system to also detect a wide range of VOC targets.

D: Detector Stage- Pulsed Discharge Ionization Detector

Uses a localized helium plasma to generate high energy photons which will ionize nearly every compound except neon. Collected charge forms the detector's signal, allowing for excellent parts per billion (ppb) to parts per trillion (ppt) sensitivity. A high dynamic range detector that requires a helium consumable.

Future Directions

- Develop a database of common VOCs detected from various soil types from both within the soil and the headspace.
- Customize the field sensing suite to detect VOCs in the field.
- Compare data from the benchtop GCMS system with the field sensing suite.

References

1. Manginell, RP, et. al. "A Monolithically-Integrated µGC Chemical Sensor System." Sensors (2011).
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3. Holopainen, JK, Gershenzon, J. "Multiple stress factors and the emission of plant VOCs". Trends in Plant Science (2010).
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