Soil Gas Analytical Methods
(Overview, TAGA, Forensics)

Ertel Facility

Dr. Blayne Hartman, H&P Mobile Geochemistry
David Mikunas, EPA-TAGA
Ms. Gina Plantz, Newfields

This presentation gives a very brief introduction to soil gas analytical methods for vapor intrusion applications. Additional discussion will be given by David Mikunas of EPA on the trace atmospheric gas analyzer (TAGA) and Gina Plantz on adsorbant methods and the use of forensics for vapor intrusion applications.

Get Enough Data

- Soil Gas Not Homogeneous
- Spatial & Vertical Variations Exist
- Don't Chase 1 pt Anomalies
- Get Enough Data Near/Around/Under
- Simpler Collection & Analyses Allow More Data for Same Cost

Soil gas, like soil, is not homogenous in most cases. So you need enough data to give decent coverage near, around, or under the receptor. Simpler collection systems with small volumes are advantageous as there is less to go wrong and enable higher production per day (20+ samples per day). Less expensive analytical methods (8021, 8260) enable more analyses for reasonable cost. Real-time data can be extremely helpful to track soil gas contamination laterally and vertically.

In the field activities tomorrow at the Ertel site, you will witness a variety of soil gas sample collection methods, some faster and simple and some more complex.

Common Soil Gas Analyses

- VOCs
  - Soil & Water Methods: 8021, 8260
  - Air Methods: TO-14, TO-15, TO-17
- Hydrocarbons
  - 8015 m, TO-3
- Oxygen, Carbon Dioxide
  - ASTM 1945-96, Method 3
- SVOCs: TO-4, TO-10, TO-13 (8270?)

This slide gives a summary of the most common analytical methods used for soil gas samples. More discussion on these methods follows.

Soil Gas Field Analyzers

- VOCs
  - Mini-Rae (ppbv) – low enough?
- Hydrocarbons
  - Portable FIDs (Foxboro, Photovac)
- Oxygen, Carbon Dioxide, Methane
  - LandTech GEM 2000
- Methane: Numerous

A variety of portable field analyzers exist for analyzing soil gas samples. For vapor intrusion applications, required detection levels of VOCs are lower than the field analyzers can reach, but they still are useful for screening sites or for sites with high concentrations. These meters give a total concentration only, so they are limited at sites with more than one compound.

Portable hydrocarbon detectors have higher detection limits (~ 1 ppmv) and do not give compound resolution.

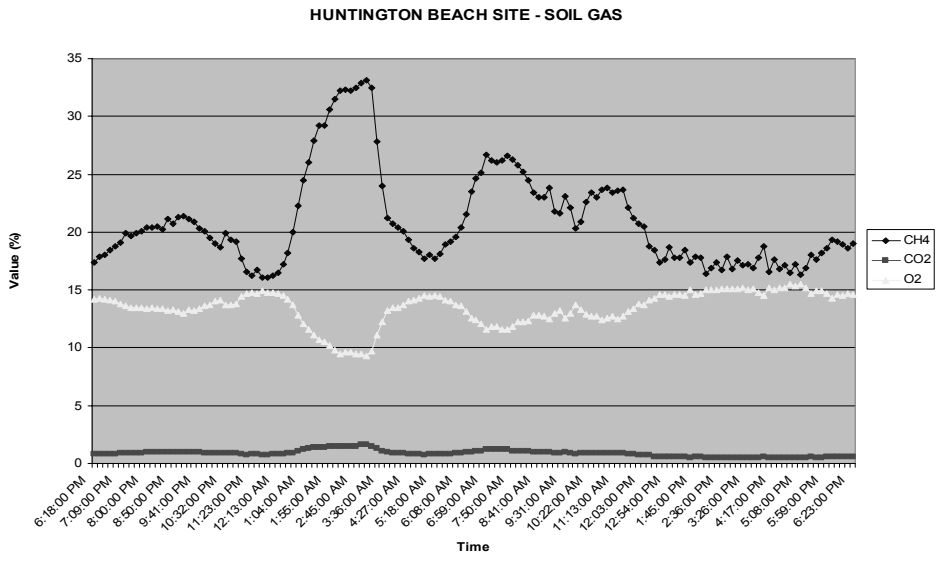
Oxygen, carbon dioxide, and methane can be reliable measured with field meters to required detection levels.

Continuous Analyzers

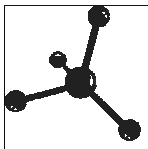
- Can Reach Ultra-Low Levels (1-10 ug/m3) for Subset of Compounds
- Can Analyze 3 to 4 Times per Hour
- Multiple Locations
- Real-Time Feedback

Automated continuous analyzers exist that run unattended enabling analysis around the clock. They can sample from multiple zones or probes and can send data over the internet in real time.

Continuous Monitoring Data

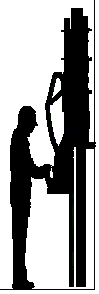


This is an example of continuous monitoring of soil gas data, in this case methane, oxygen, and carbon dioxide in a vapor well. Similar data collected inside a structure could be useful in differentiating between vapor intrusion and ambient/background scatter. Or it can be used to demonstrate the repeatability of shallow soil gas data.



Soil Gas VOC Analysis
(TO-14/15/17 or 8260 or 8021)

- All Methods Give Reliable Results
- Detection Level Discriminator
  - TO Methods: <1 to 10 ug/m^3 $200-$300
  - 8260 SIM: 10 to 50 ug/ m^3 $100-$150
  - 8021: 50 ug/m^3 $75 to $100
- On-Site Analysis
  - Extremely Helpful for VI
  - Minimizes False Positives

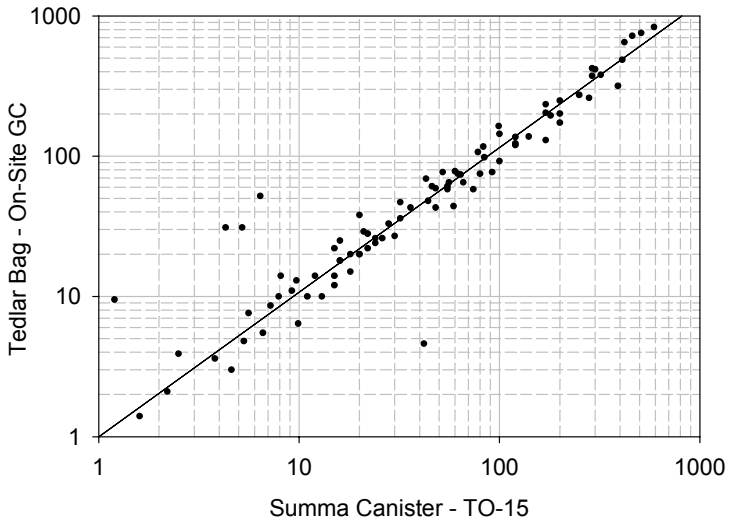


A variety of analytical methods are available to measure soil gas samples. No federal guidance document exists specifying any one. Methods 8021 and 8260 are soil & water methods but give accurate results for soil gas samples at detection levels above 10 ug/m3. The toxic organic methods (TO) are designed for ambient air samples, so they give accurate results for soil gas samples at much lower detection levels. The TO methods require extensive hardware and are far more expensive.

The criteria for selection should be which method(s) reach the required detection limits.

On-site data are extremely useful to ensure that the samples do not have tracer/leak levels above acceptable levels, provide real-time data for decision making, and to validate detections seen in the off-site data. If measured values are high, then the on-site methods (8021, 8260) are more appropriate to use than the ultra-sensitive TO methods. If on-site values are low or below detection, then the samples can be measured off-site by the TO methods.

On-Site 8021 Analysis vs. Off-site TO-15 Analysis



This slide shows a comparison of on-site analysis of TCE by 8021 out of a tedlar vs. off-site analysis by TO-15 out of a Summa canister collected by EPA-ORD at a test site. Correlation is excellent down to values as low as 2 ppbv.

Slide courtesy of Dr. Dominic DiGuilio, EPA-ORD

High SG Concentrations Create Headaches

- Typical Soil Gas Concentrations
  - Benzene near gasoline soil: >100,000 ug/m3
  - TPH vapor: >1,000,000 ug/m3
  - PCE under dry cleaner: >100,000 ug/m3
- TO-15 Maximum Conc: 2,000 ug/m3
  - Must do large dilutions, DL goes up
  - False positives from hot samples
- Canister & Hardware & Instrument Blanks

Typical soil gas concentrations at leaky UST, dry cleaner, and industrial solvent sites are in the 100,000s to 1,000,000 of ug/m3. But, for 1 in 1 million risk , the risk-based screening levels are less than 10 to 100 ug/m3. This large concentration range creates a number of analytical headaches.

The TO-methods and hardware (canisters, flow chokes) are not designed for such high concentrations. System carryover, large dilutions, and contaminated canisters increase the potential for false positives, raises reporting levels, and gives air labs logistical fits which limits the utility of these methods.

The 8260 and 8021 methods can't get lower than 10 to 100 ug/m3 so they may not reach required DLs.

In practice, a combination of these methods is the best approach. If expected values are high, then the 8021 & 8260 are advantageous to use than the ultra-sensitive TO methods. If expected values are low, then the TO methods offer advantages.

Not All TO-15s Are Alike

- Standard Method QA/QC Poor
  - Does Not Meet Many States Requirements
  - Can use standard for a year!!
  - No second source standard
  - No surrogates
  - Wider calibration acceptance windows
- Beware the "Wal-Mart TO-15"
  - Only use labs that have upgraded method
  - Only use lab that has a certification

The TO-15 analytical method has been advertised as the "Gold Standard", but actually, the QA/QC is very poor and does not match the requirements of many State agencies. Further, it may have difficulty meeting the legal challenge. Incredibly, most State regulatory personnel don't realize this. Some States, like NJ, have published a more exacting method than the standard method.

The higher-quality labs have upgraded the method to meet more exacting requirements required by the EPA SW-846 methods or any specific State regulatory requirements, such as second source standards & surrogates.

Beware the "Wal-Mart TO-15". To ensure that you are getting a quality analysis, only use labs that can show they have upgraded the method QA/QC and have a certification from some NELAC or a State agency.

On-Site/Off-Site Analysis

- Allows Measure of Leak Compound
  - Ensures valid samples
- Real-Time Results to Guide Program
- Inconsistent Data can be Recollected
- Validates Off-site Data
  - Minimizes false positives
- Allows Optimal Method to Be Used
  - 8260 if > 1 ug/L, TO-15 if < 1 ug/L

On-site data are extremely useful to ensure that the samples do not have tracer/leak levels above acceptable levels, provide real-time data for decision making, and to validate detections seen in the off-site data. If measured values are high, then the on-site methods (8021, 8260) are more appropriate to use than the ultra-sensitive TO methods and much less costly. If on-site values are low or below detection, then the samples can be collected & measured off-site by the TO methods.

Previous Ertel TCE Results
(in ug/L)

Location	8021 (50 cc)	TO-15 (1000 cc)	
P4-7’	114	110	
P5-11’	23-32	30	
SS-D-2	6-8	15	
SS-D-3	280-334	300	
G1-3’	26	28	
G4-7’	15	36	

These are the results from the July 2006 soil gas survey conducted at the Ertel test site. Concentrations are extremely high (1 ug/L = 1000 ug/m3). The on-site 8021 data match the off-site TO-15 data very well.

Tomorrow's Activities

- Various Collection Methods
  - Syringe, Tedlars via Lung Box, Canisters, Adsorbants
- Real Time Analyses
  - TAGA, IDEM GC, Hand Meters

In the field tomorrow will be a variety of sampling and analytical methods. Samples will be collected using small volume syringes, in tedlar bags using vacuum boxes, in canisters, and on adsorbants.

Real-time analysis will be offered by the EPA TAGA mobile laboratory, by the Indiana Dept. of Env. Management (IDEM) mobile laboratory using 8021, and with hand-held meters. The concentrations are extremely high, so dilutions will be necessary by the mobile labs and the portable meters should work well.

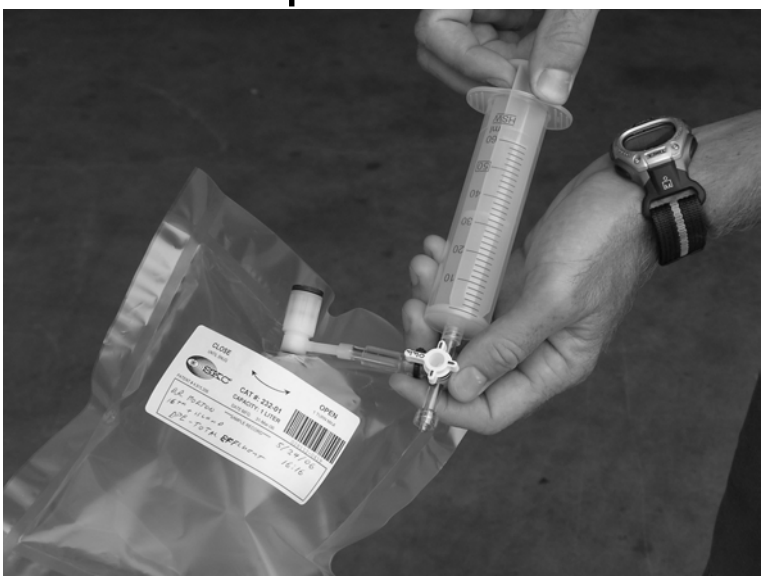
Sample Volumes

A 6-liter Summa can is about the size of a basketball. A 400 cc mini-can is about the size of a baseball.

Lower volumes give more control on sample location, require less time to collect, and minimize chances of breakthrough from the surface or other sampling zones in nested wells.

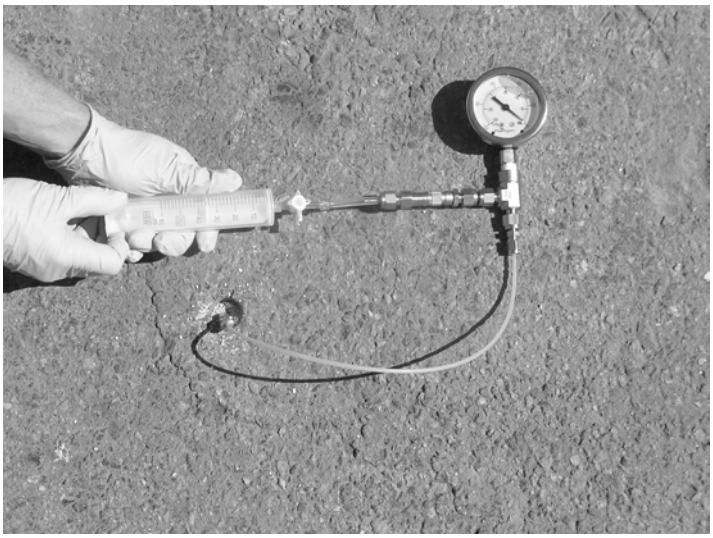
For soil gas samples, most labs only require 100 cc of sample, so small canisters (<1 liter) are sufficient volume.

Sample Collection



Collection of a soil vapor sample in a tedlar using a syringe. No power required, no complicated fittings. Leak/tracer can be applied prior to sample collection.

Purging

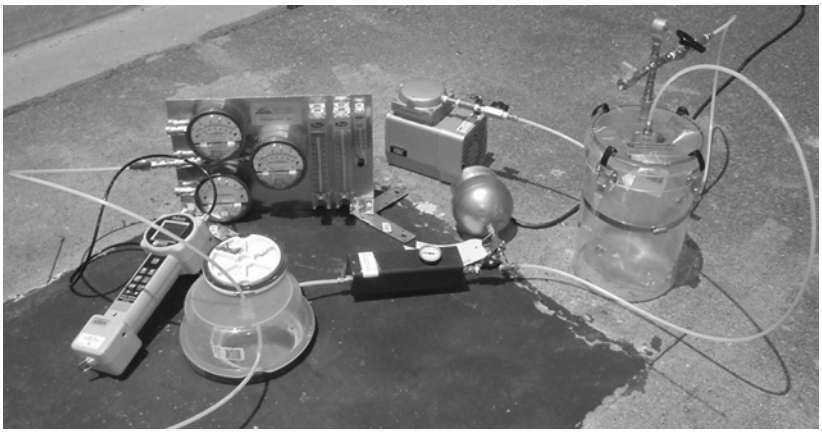


A simple and fast procedure to purge soil vapor probes is to use a disposable gas-tight syringe. Volumes can be carefully measured, the collector can get a feel for the permeability of the sampling zone from the syringe resistance, low vacuums and flow are applied, and no bulky hardware or power is required.

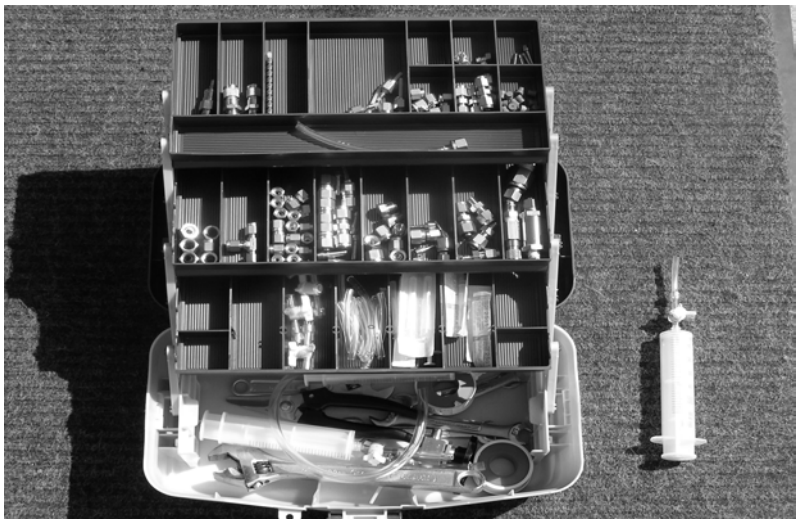
Sample Collection

Collection of a soil vapor sample in a mini-Summas (400 cc). Leak/tracer can be applied prior to sample collection.

Sample Collection



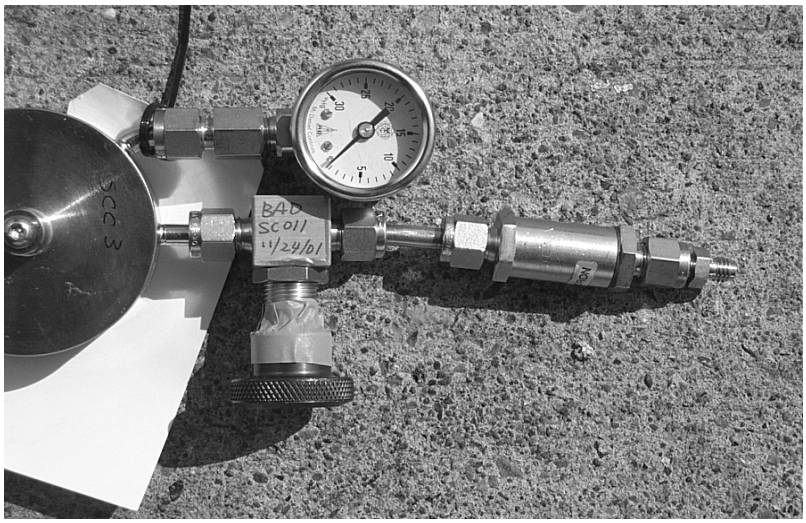
Beware of the Hardware



The tackle box on the left shows the required hardware to collect soil gas samples in Summas.

The syringe to the right is the only collection device required for on-site analysis of soil gas.

Beware of the Hardware



This is a picture of some hardware provided to us by an air lab for a project. Note the label indicating the valve is “bad” and the green tape holding the valve knob in a set position.

Be sure the lab you select has good hardware!