Field application of soil sample preservation using BS10176 method - case studies for a range of sites and contaminants

Background

Traditional methods of collecting soil samples for Volatile Organic Compound (VOC) analysis are still widely being used in Land Quality Investigations. The issue with the continued use of these methods is a potential loss of VOCs during sampling disturbance and transportation, which could result in a conclusion of lower vapour intrusion risk than is actually present during human health risk assessments. The publication of BS 10176:2020 (BS10176) outlined various soil sampling methods which aimed to minimise the loss of VOCs from soils during sampling, one of which is methanol preservation.

Objectives

To trial an application of BS10176 soil sampling method using methanol preservation under field conditions and evaluate it against traditional field (photoionisation detector headspace) and laboratory sampling methods and to establish an in-house standard operating procedure.

Health and safety considerations

Methanol is highly volatile, flammable and toxic. Therefore, use of methanol preservation during soil sampling requires appropriate health and safety management to prevent accidental spillage, unnecessary exposure to atmosphere and ingestion. The sampling method trialed the use of a small sampling table set up in a well-ventilated area and test tube rack to ensure methanol filled vials were secured and could not spill. The trialed set up enabled the handling of the methanol vials to be minimised to a very short duration per sample (5 to 10 seconds). The method could also be updated to include a gazebo or canopy for inclement weather.

Field set-up

1. An impermeable groundsheet was used to prevent methanol from entering the environment in case of a spill.
2. A camping table was used to provide a stable surface for the sampling equipment.
3. A test tube rack secured the laboratory supplied methanol charged vials in place during sampling.
4. A kneeling pad was used for the comfort of the on-site engineer during sampling.
5. Cool boxes were placed nearby so that once collected, samples were safely stored, and temperatures maintained.
6. The laboratory provide pre-weighed vials (2 per sample) pre-charged with methanol in which to place the soil sample.
7. Soil samples were collected from the core runs using a reusable plunger/corer sampler which is designed to collect 5g of sample.
8. Single use liners were inserted into the sampler and then pushed into the soil to collect the sample. The plunger was then depressed into the vials to extrude the soil sample before immediately sealing the vials and storing them in cool boxes.

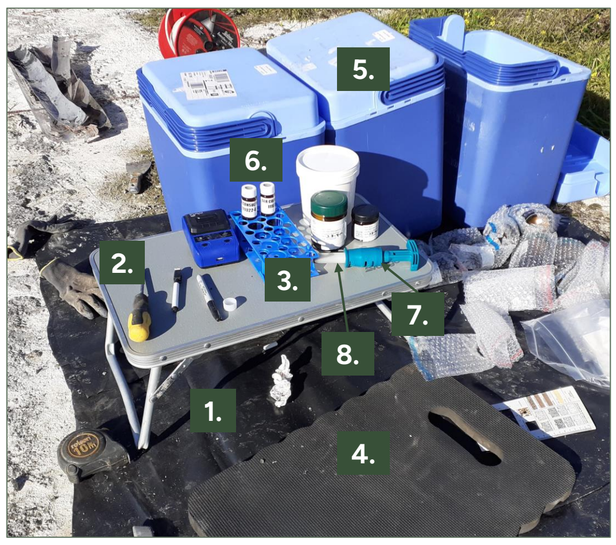

Fig 1. Field application of BS10176 soil sampling method using methanol preservation.

Methodology

1. Pre-set the green reusable sampler by pulling the plunger to the 5g setting and twist the plunger clockwise 90° to lock in position.

2. Open the liner like a syringe so there is a void for the sample in the bottom of the liner.

3. Insert the liner into the bottom of the sampler and twist clockwise 90° to lock in position.

4. Using the sampler, push the disposable liner into the sample which will sample the 5g of sample required.

5. Remove the cap from the methanol vial and place the soil filled liner over the open vial. Unlock the plunger handle and depress the plunger to extrude the soil.

6. Replace the cap tightly ensuring there is no soil in the threads of the vial or cap. Repeat using the same sample liner to fill the second vial.

Photographs and descriptions were adapted from field help sheets provided by Element Materials Technology.

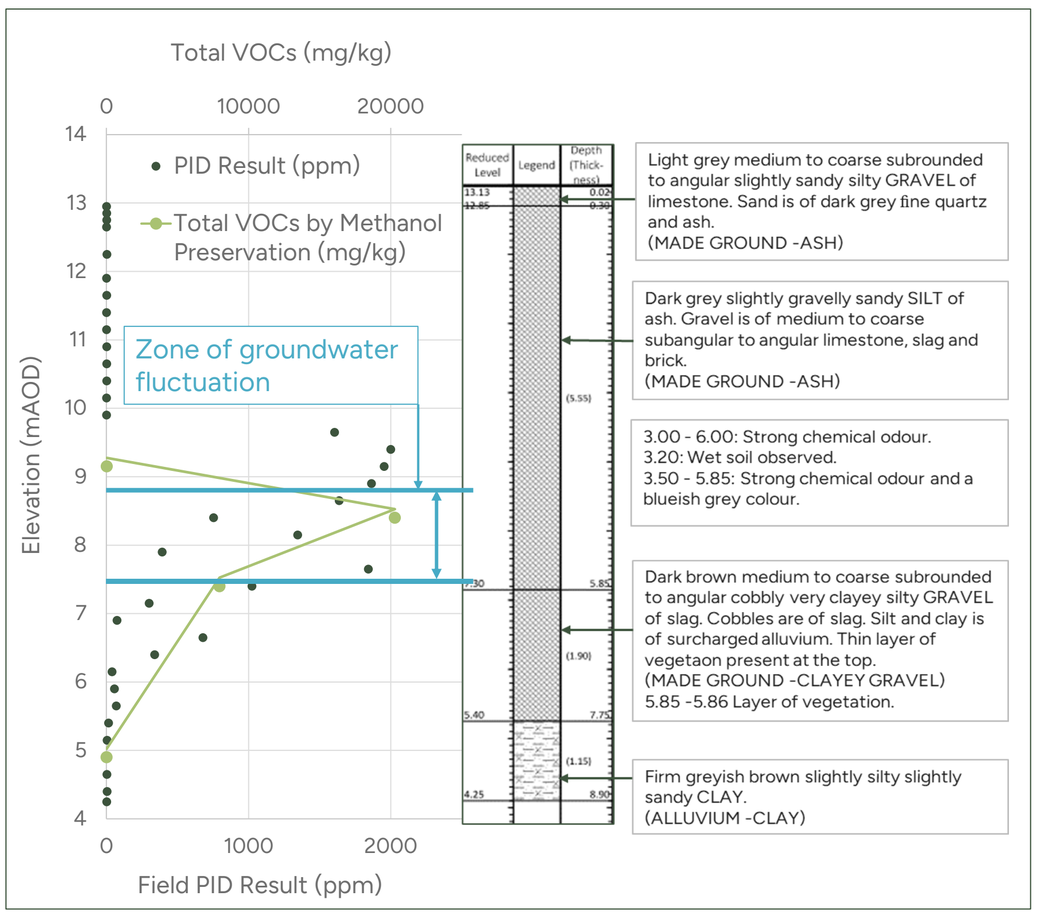

Fig 2. A comparison of field PID results and total VOCs using BS10176 methanol preservation method. The borehole log is presented adjacently with geological descriptions of the soil.

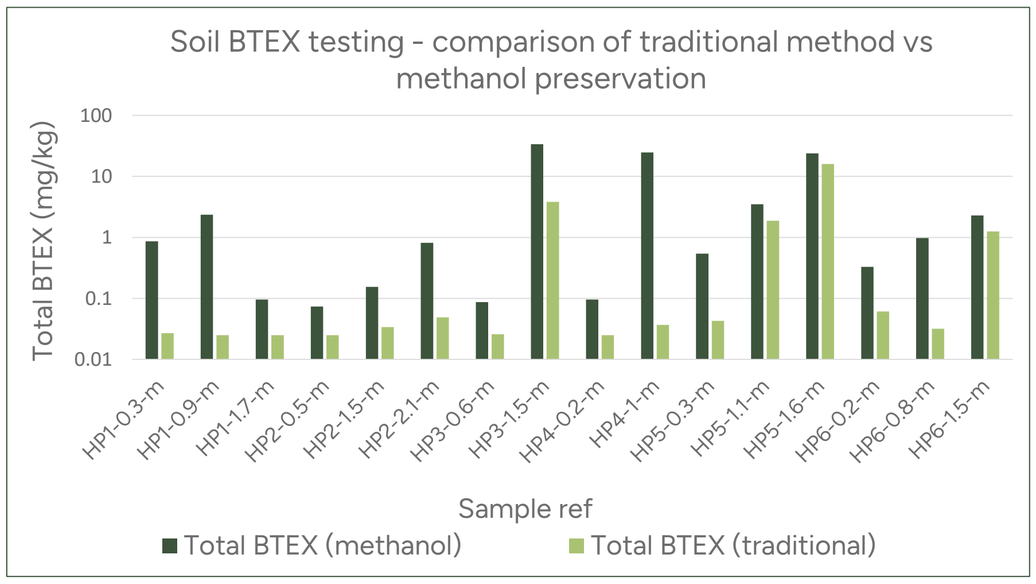

Fig 5. A comparison of total BTEX concentrations using traditional soil sampling method against using BS10176 methanol preservation method.

Results

Case Study 1 - Chemical Works in Northwest England

The BS10176 field methodology was used to assess the levels of chlorinated solvents within ash sediment at a chemical works.

To inform the depths at which to take a sample, a 11.6eV photo-ionization detector (PID) was used to measure head space concentrations at 0.25m intervals (Fig. 2).

The contamination zone was apparent due to a change in colour from brownish grey to blueish grey ash sediment, as well as a strong chemical odour from 9.7mAOD to 5.5mAOD (Fig. 3).

The PID results reflected these field observations with a maximum head space reading of 2000ppm at 9.4mAOD. BS10176 methanol samples were then collected at locations above, within and below the zone of contamination.

Figure 2 compares PID results and total VOCs (using BS10176 method) with elevation in metres above Ordnance Datum (mAOD). There is a clear correlation between field PID results and the chlorinated solvent VOC concentration.

Fig 3. Photograph of drill arisings showing a change in soil colour, the threshold at which less impacted brownish grey ash sediment above (10mAOD) separates highly impacted blueish grey ash sediment below (9mAOD).

Case Study 2 – Petrol Filling Station in Eastern England

A site investigation was conducted to assess petroleum hydrocarbon impact within shallow superficial deposits of silty sandy clay (Fig. 4).

As part of this assessment, standard soil samples we collected alongside methanol preservation samples to compare the difference in BTEX (benzene, toluene, ethylbenzene and xylene) concentrations.

The BS10176 samples recorded significantly higher results than traditional sample methods; some of which are orders of magnitude greater (Fig. 5).

Interestingly, the variation is much more pronounced for trace concentrations, than higher concentrations above 1mg/kg.

This comparison highlights the effectiveness of soil sampling using BS10176 method and has implications for site investigation design where VOCs are a contaminant of concern.

Fig 4. Hand auger arisings from HP3 (1.2-2.1m depth). Elevated PID readings and a strong hydrocarbon odour were recorded between 1.4-1.7m depth.

Conclusions

The trial established a safe and easily reproducible sampling method that could be adapted as a future standard operating procedure document.

The case study sampling results demonstrated that, in combination with appropriate field screening, the use of methanol preservation provides a more accurate method for characterising VOC impact in cohesive soils than traditional soil sampling methods, both for chlorinated VOCs and petroleum hydrocarbons (BTEX). This is particularly important for consideration where initial screening of potential vapour intrusion risks are completed using soil data and comparison with GACs.

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References

BS 10176:2020 Taking soil samples for determination of volatile organic compounds (VOCs) - Specification