

**Metropolitan Museum of Art**  
**Gas Chromatography- Mass Spectrometry (GC-MS) Results from Material Analysis**

This document includes (1) a mass spectrum and (2) the volatile organic compounds (VOCs) emitted from samples using GC-MS analysis. The data is not interpreted; however, several classes of chemicals are highlighted because they are potential risks for artwork in an enclosed environment. A basic key, provided below, indicates those classes. The amount of each chemical identified has not been determined; similarly, it is not known how much of each chemical is necessary to do damage to art. Finally, peaks may be present that are the result of the sample adsorbing chemicals from the air and reemitting them during testing rather than being inherent to the sample. Research is ongoing to determine specifically which chemicals and amounts are required to negatively affect artifacts.

**Highlighted data:**

Pink – chemicals currently known to be hazardous to art

Green – amines; can raise the pH, are suspected to react with acids and may form crystals in an enclosed environment

Yellow – chemicals of the following type, which *may* be hazardous to art:

*Acids* – lower the pH, corrosive to metals, degrade organic materials

*Aldehydes* – can convert to acids with heat or exposure to UV light

*Esters* – can hydrolyze into acids with heat and humidity

*Sulfur-containing compounds* – known to tarnish and corrode some metals

*Halogenated compounds* – can become reactive with exposure to heat and UV light

*Nitrogen-containing, not amine* – can react with other off-gassed chemicals

*Alkynes* – can become reactive when exposed to heat or UV light

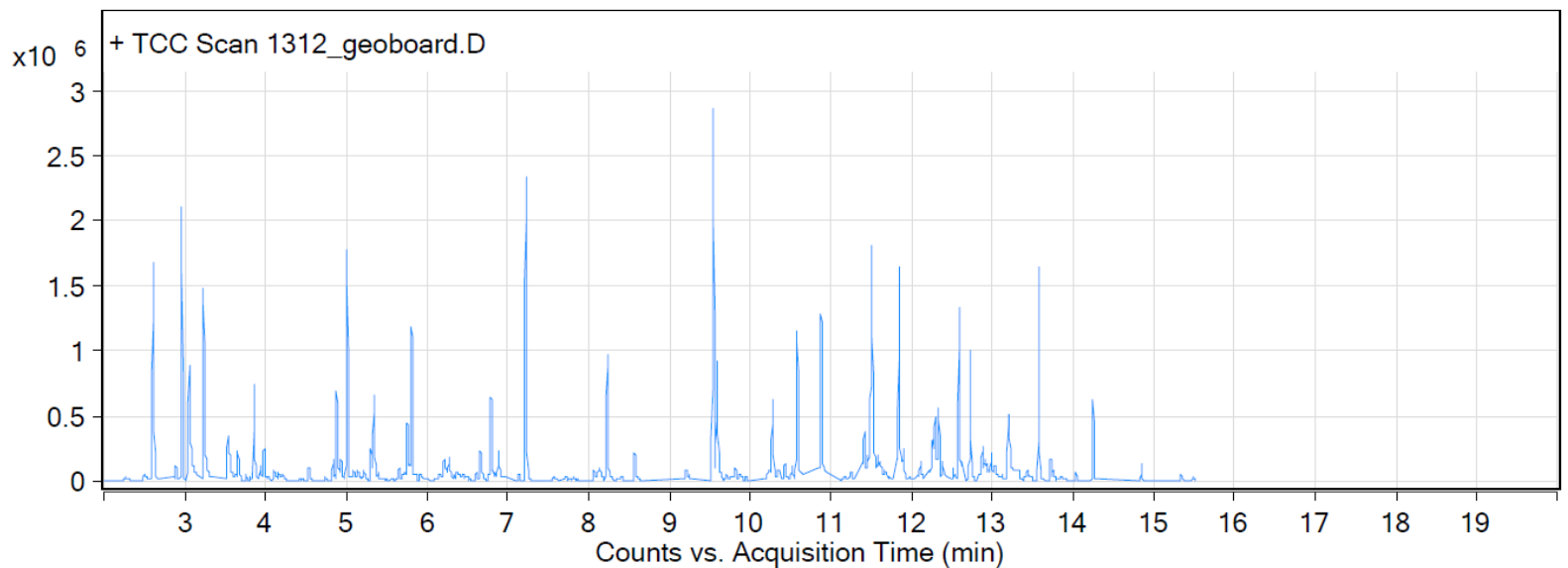
Sample: Geoboard decorative cement board

Oddy test score: Temporary

Date collected: 05/17/2016

Technique used: SPME with a PDMS/DVB fiber; Agilent 7890B GC and 5977B MS fitted with a GL Sciences OPTIC-4 multimode inlet and LEAP PAL RTC autosampler; Pre-heated at 60°C for 20 minutes; fiber exposure at 60°C for 20 minutes; sample injected into 220°C inlet and crotrapped for 2 min at -15°C; GC ramped from 40°C to 225 °C at 10°C/min. Data analyzed in masshunter Qualitative. Samples > 80% match with a NIST 17.0 library are reported.

VOCs not highlighted are because they were also observed in blanks: 11.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Name	DB Formula
Tetrahydrofuran	C4H8O
Benzene, methyl-	C7H8
Hexanal	C6H12O
Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
Furfural	C5H4O2
2-Furanmethanol	C5H6O2
Benzene, ethyl-	C8H10
unidentified C2-benzene	C8H10
Formic acid, butyl ester	C5H10O2
2-Heptanone	C7H14O
Benzaldehyde	C7H6O
Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
Benzene, 1,2,3-trimethyl-	C9H12
Decane	C10H22
1-Hexanol, 2-ethyl-	C8H18O
dl-Limonene	C10H16

Undecane	C11H24
Nonanal	C9H18O
Dodecane	C12H26
Tridecane	C13H28
Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	C12H24O3
Tetradecane	C14H30
3-Ethyl-2,6,10-trimethylundecane	C16H34
Pentadecane	C15H32
Hexadecane	C16H34
1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	C16H22O4
5-Amino-2-methyl-2-phenyl-2,3-dihydro[1,2,4]triazolo[1,5-a][1,3,5]triazine	C11H12N6