

## 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

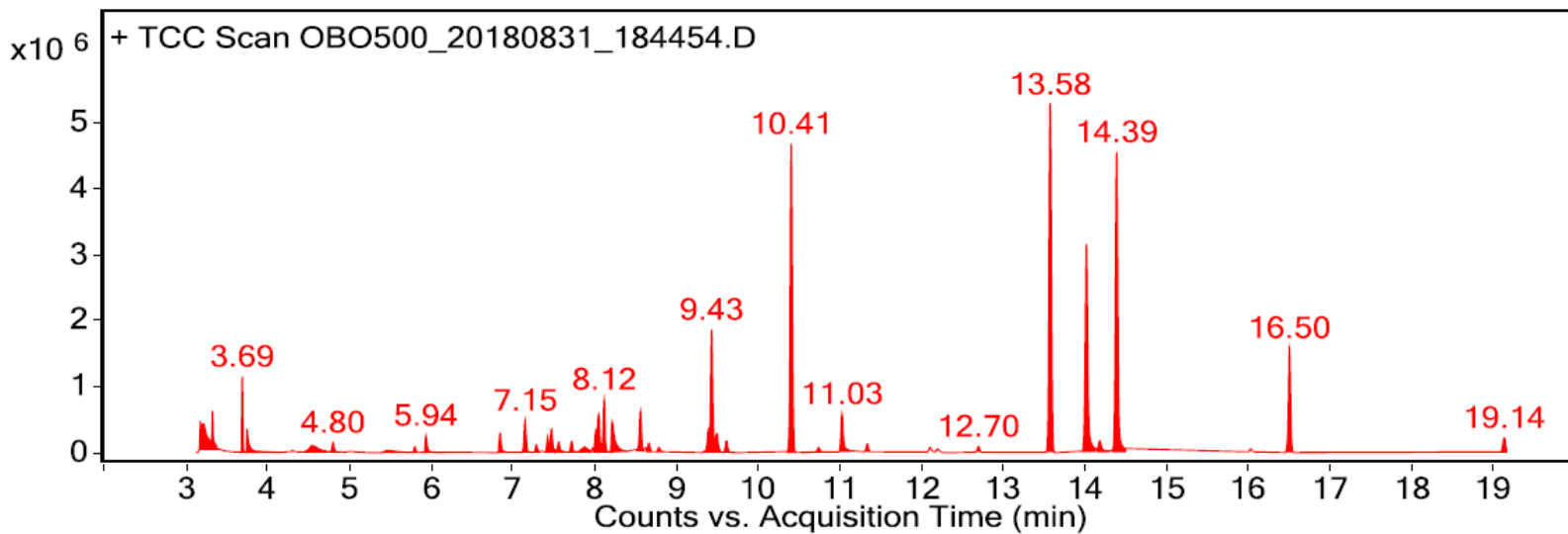
Sample: Obomodulan 500 magma foamed polyurethane board

Oddy test result: Permanent

Date collected: 08/31/2018

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 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) ~5.8 min: methoxy-phenyl oxime (2) 14.0 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 14.4 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.210	92.4	C7H8	92.1	3115801	108-88-3	Benzene, methyl-
3.330	97.4	C2H4O2	60.0	375331	64-19-7	Acetic acid
3.690	93.7	C2H8O2Si	92.0	849007	1066-42-8	Silanediol, dimethyl-
3.750	92.7	C6H15N	101.1	631520	121-44-8	Ethanamine, N,N-diethyl-
4.540	89.4	C6H5Cl	112.0	325670	108-90-7	Benzene, chloro-
4.540	94.0	C6H5Cl	112.0	316276	108-90-7	Benzene, chloro-
4.800	93.9	C6H18O3Si3	222.1	191196	541-05-9	Cyclotrisiloxane, hexamethyl-
5.800	85.0	C8H9NO2	151.1	134312	1000222-86-6	Oxime-, methoxy-phenyl-
5.940	92.0	C6H14O2	118.1	391323	111-76-2	Ethanol, 2-butoxy-
6.840	95.9	C7H6O	106.0	512107	100-52-7	Benzaldehyde
7.150	95.1	C6H6O	94.0	822233	108-95-2	Phenol
7.290	81.4	C4H6O3	102.0	175703	108-32-7	1,3-Dioxolan-2-one, 4-methyl-
7.430	87.8	C6H10O4	146.1	325999	111-55-7	1,2-Ethandiol, diacetate
7.470	97.1	C8H24O4Si4	296.1	626749	556-67-2	Cyclotetrasiloxane, octamethyl-
7.560	90.9	C8H16O	128.1	250949	124-13-0	Octanal
7.720	86.9	C10H16	136.1	265633	99-85-4	gamma.-Terpinene
8.020	92.2	C8H18O	130.1	601675	104-76-7	1-Hexanol, 2-ethyl-
8.050	93.5	C10H16	136.1	812340	138-86-3	dl-Limonene
8.120	96.3	C7H8O	108.1	672717	100-51-6	Benzenemethanol
8.220	97.1	C5H9NO	99.1	1215085	872-50-4	2-Pyrrolidinone, 1-methyl-
8.560	91.6	C15H32	212.3	1057270	3891-98-3	Dodecane, 2,6,10-trimethyl-
8.670	89.1	C11H24	156.2	248555	17302-23-7	Nonane, 4,5-dimethyl-
8.790	90.3	C8H18O	130.1	121131	111-87-5	1-Octanol
9.430	96.9	C9H18O	142.1	2978564	124-19-6	Nonanal
9.500	86.8	C15H32	212.3	220085	629-62-9	Pentadecane
10.410	94.4	C10H30O5Si5	370.1	8552981	541-02-6	Cyclopentasiloxane, decamethyl-

10.740	82.9	C10H20O	156.2	130261	2216-52-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, [1S-(1.alpha.,2.alpha.,5.beta.)]-
11.030	94.6	C8H18O3	162.1	1185811	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
11.340	92.1	C10H20O	156.2	198941	112-31-2	Decanal
12.700	85.4	C19H40	268.3	173698	629-92-5	Nonadecane
14.020	89.7	C12H24O3	216.2	6789089	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
14.390	88.3	C12H24O3	216.2	9196041	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester