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

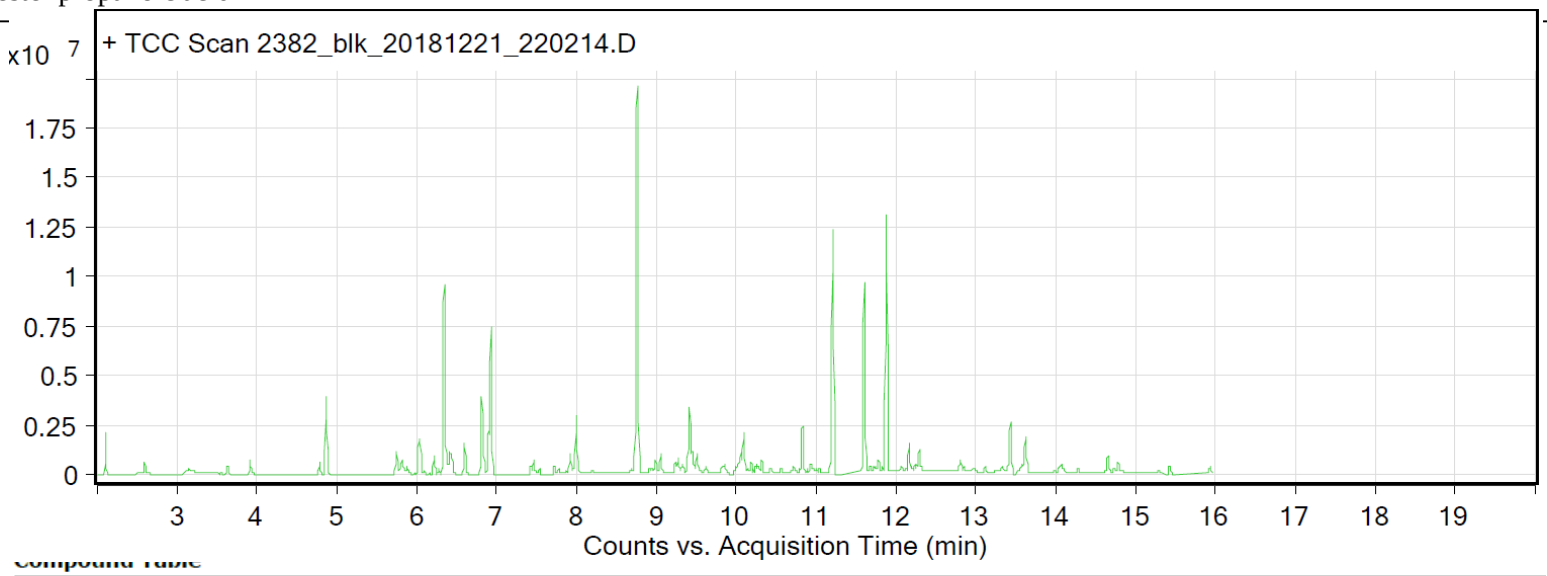
Sample: Talas; Museum board Black

Oddy test result: temporary

Date collected: 12/21/2018

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 cryo-trapped for 2 min at -15°C; GC ramped from 35°C to 250 °C at 10°C/min. Data analyzed in Masshunter Qualitative Analysis. Deconvoluted data with > 85% match with a NIST 17.0 or Wiley 9 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 4.8 min: methoxyphenyl oxime; (2) 11.6 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 11.9 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



RT	Score (Lib)	Area	Name	Formula
1.5	98.95	645685	Acetic acid	C2H4O2
2.1	93.68	2046909	Silanediol, dimethyl-	C2H8O2Si
2.59	94.56	479157	(S)-(+)-1,2-Propanediol	C3H8O2
3.15	93.3	2339323	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.33	88.96	451357	3-Furaldehyde	C5H4O2
3.63	91.67	707410	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.91	97.26	1117102	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
4.78	85.44	918068	Oxime-, methoxy-phenyl-_	C8H9NO2
4.86	97.52	4399012	Ethanol, 2-butoxy-	C6H14O2
5.74	97.7	1771359	Benzaldehyde	C7H6O
6.22	94.85	1535075	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
6.28	95.18	467561	Benzene, 1,2,3-trimethyl-	C9H12
6.34	96.5	15822818	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.38	94.51	887851	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.41	93.58	919866	Octanal	C8H16O
6.44	88.49	953800	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.6	96.54	2448861	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.81	97.16	5738700	1-Hexanol, 2-ethyl-	C8H18O
6.84	96.01	1293310	dl-Limonene	C10H16
6.9	92.65	1504644	Benzyl Alcohol	C7H8O
6.93	97.37	11143980	Benzene, 1,3-dichloro-	C6H4Cl2
7.43	98.34	533766	Ethanone, 1-phenyl-	C8H8O
7.46	93.4	987039	1-Octanol	C8H18O
7.54	87	365829	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
7.72	85.09	421750	Benzoic acid, 4-methyl-, 2-hydroxy-2-phenylpropyl ester	C17H18O3
7.92	85.94	1656916	Undecane	C11H24
7.99	98.12	4603341	Nonanal	C9H18O
8.69	86.93	485930	Acetic acid, 2-ethylhexyl ester	C10H20O2

8.72	86.73	381594	2-methoxy[1]benzothieno[2,3-c]quinolin-6(5H)-one	C16H11NO2S
8.76	96.15	34795100	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.98	88.36	596011	Decyl heptyl ether	C17H36O
9.05	98.38	1415305	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(.+/-.)-	C10H20O
9.27	94.97	1024846	Ethanol, 2-(2-butoxyethoxy)-	C8H18O3
9.33	91.98	549140	.alpha.-Terpineol	C10H18O
9.41	96.14	4981106	Dodecane	C12H26
9.45	85.19	759232	Ethyl (E)-2',2'-difluorohexadec-13-enoate	C18H32F2O2
9.51	97.79	1453973	Decanal	C10H20O
9.85	90.8	791764	2-Ethylhexyl acrylate	C11H20O2
10.18	86.62	949720	2-Propenoic acid, octyl ester	C11H20O2
10.32	86.92	997570	2-PROPENOIC ACID, ISODECYL ESTER	C13H24O2
10.43	90.03	418333	1-Decanol	C10H22O
10.56	88.45	432104	Undecane, 3,8-dimethyl-	C13H28
10.71	85.63	757642	Cyclotridecane	C13H26
10.83	95.28	3729607	Tridecane	C13H28
10.94	88.91	922595	Undecanal	C11H22O
11.18	89.68	880508	Nonane, 2,2,4,4,6,8,8-heptamethyl-	C16H34
11.21	96.44	22446471	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.6	89.3	16235077	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.78	89	640846	Tridecane, 3-methyl-	C14H30
11.88	93.74	22350331	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.16	96.01	2279355	Tetradecane	C14H30
12.29	97.03	891062	Dodecanal	C12H24O
12.81	87.16	1131591	Heptyl tetradecyl ether	C21H44O
12.96	87.04	605601	Tetradecane, 4-methyl-	C15H32
13.57	93.91	739737	Tridecanal	C13H26O
13.62	89.65	1403097	Tetradecane, 2,2-dimethyl-	C16H34
14.28	85.19	377607	Pentadecane, 3-methyl-	C16H34
14.65	93.93	1987213	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
14.78	96.73	901265	Tetradecanal	C14H28O
15.28	86.22	357085	Cyclopentane, nonyl-	C14H28
15.43	88.71	878700	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8