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

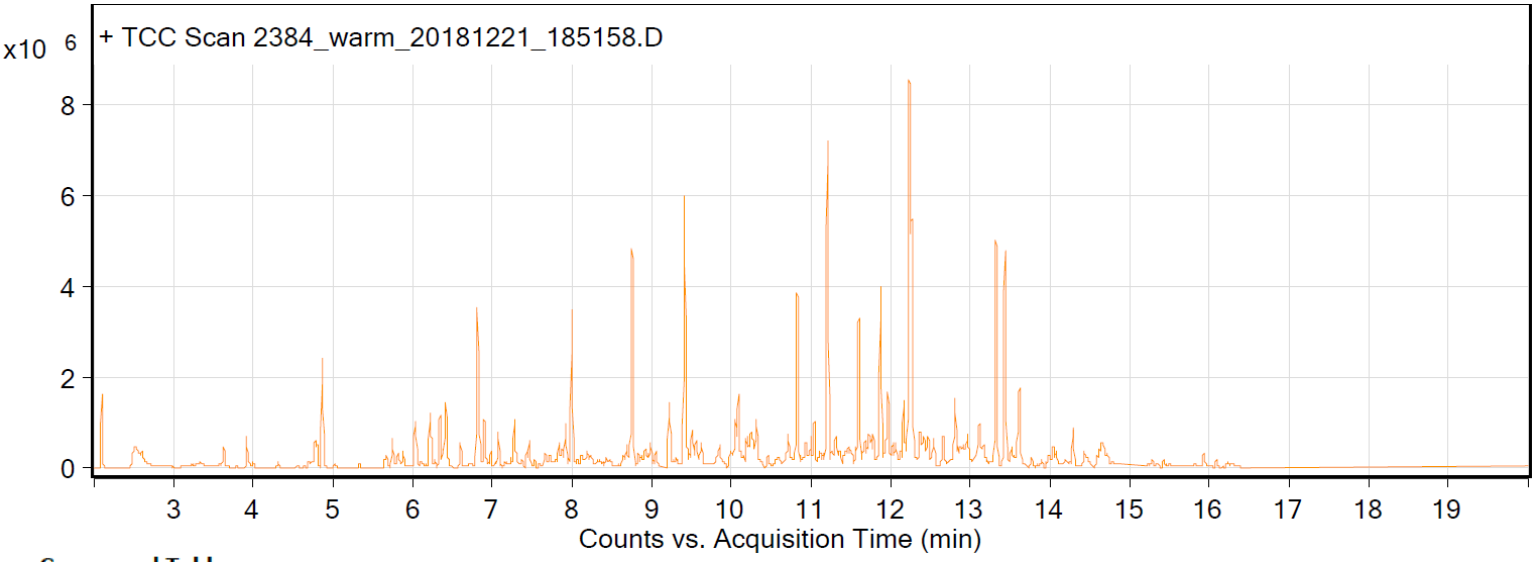
Sample: Talas; Museum board warm white

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



Compound Table

RT	Score (Lib)	Area	Name	Formula
1.48	98.55	311824	Acetic acid	C2H4O2
1.76	88.02	160512	Benzene, methyl-	C7H8
2.09	93.65	1480496	Silanediol, dimethyl-	C2H8O2Si
2.51	94.85	3635091	Hexanal	C6H12O
2.6	88.08	137109	Methoxypropionaldehyde	C4H8O2
3.16	88.18	1076677	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.63	92.46	703911	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.91	97.43	667925	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
4.78	85.3	609863	Oxime-, methoxy-phenyl-_	C8H9NO2
4.8	92.01	848809	N HEPTANAL	C7H14O
4.86	97.42	2759136	Ethanol, 2-butoxy-	C6H14O2
5.02	89.83	152040	2(3H)-Furanone	C4H4O2
5.67	95.09	338121	2-Heptenal, (E)-	C7H12O
5.74	97.8	983071	Benzaldehyde	C7H6O
5.88	87.48	523771	1-Heptanol	C7H16O
6.21	93.06	1899657	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
6.24	90.28	447652	Furan, 2-pentyl-	C9H14O
6.27	93.46	181495	unidentified C3-benzene	C9H12
6.34	95.98	1765968	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.38	92.9	271428	O-Ethyl-1,3-dioxolanium	C5H11O2
6.41	96.11	1775638	Octanal	C8H16O
6.6	96.53	861576	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.81	96.77	5204660	1-Hexanol, 2-ethyl-	C8H18O
6.84	95.64	1070787	dl-Limonene	C10H16
6.9	96.77	747420	Benzyl Alcohol	C7H8O
6.98	88.19	239498	3-Octen-2-one	C8H14O
7.07	90.28	1075133	Hexane, 1-nitro-	C6H13NO2
7.28	96.98	817802	2-Octenal, (E)-	C8H14O
7.37	90.45	166517	Octane, 2,6-dimethyl-	C10H22
7.43	96.82	464257	Ethanone, 1-phenyl-	C8H8O

7.46	97.62	756680	1-Octanol	C8H18O
7.54	87.64	247905	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
7.87	92.82	211054	Benzoic acid, methyl ester	C8H8O2
7.92	96.86	1403059	Undecane	C11H24
7.99	98.47	5176436	Nonanal	C9H18O
8.69	92.57	504127	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.75	95.29	8418644	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.83	95.01	472413	trans-2-Nonenal	C9H16O
8.98	89.32	560354	Undecane, 2,3-dimethyl-	C13H28
9.05	92.21	477587	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(.+/-.)-	C10H20O
9.22	95.84	1917507	Ethanol, 2-(2-ethoxyethoxy)-, acetate	C8H16O4
9.41	95.85	7848840	Dodecane	C12H26
9.51	98.38	1188149	Decanal	C10H20O
9.85	91.58	768737	2-Propenoic acid, 6-methylheptyl ester	C11H20O2
10.31	86.64	1262272	2-Decenal, (E)-	C10H18O
10.46	95.49	451234	n-Propyl benzoate	C10H12O2
10.71	95.16	1209994	1-Tridecene	C13H26
10.82	95.49	5933304	Tridecane	C13H28
11.18	87.33	397478	Nonane, 2,2,4,4,6,8,8-heptamethyl-	C16H34
11.21	95.92	8838393	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.31	87.37	369717	Heptadecane, 7-methyl-	C18H38
11.6	88.77	4073821	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.78	91.52	1207490	Tridecane, 3-methyl-	C14H30
11.87	93.29	6902456	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
11.96	96.8	2258818	1,1'-Biphenyl	C12H10
12.06	94.84	733267	1-Tetradecene	C14H28
12.16	95.46	2235383	Tetradecane	C14H30
12.23	93.19	12435888	1,1'-Biphenyl, 2-methyl-	C13H12
12.26	95.29	7372690	Benzene, 1,1'-oxybis-	C12H10O
12.54	94.48	623681	1,1'-biphenyl, 2,6-dimethyl-	C14H14
12.66	89.79	1053193	Diphenylmethane	C13H12
12.81	87.97	1633314	1-Tetradecanol	C14H30O
12.96	85.46	576572	Hexadecane, 2,6,11,15-tetramethyl-	C20H42
13.32	94.85	7513158	Diphenylmethane	C13H12
13.52	93.18	693804	bis(2-Ethylhexyl) ether	C16H34O
13.6	92.44	1309737	1,1'-Biphenyl, 2,3'-dimethyl-	C14H14
13.62	90.02	1114386	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
13.77	94.47	366597	Benzene, 1,1'-(1,2-ethanediyl)bis-	C14H14
13.84	85.07	130353	Benzene, 1-methyl-4-(phenylmethyl)-	C14H14
13.89	92.89	251285	Benzene, 1-methyl-4-(phenylmethyl)-	C14H14
14.08	85.62	546101	n-Nonylcyclohexane	C15H30
14.29	85.68	1382257	1-METHYL-2-(PROPENYLOXY)-ETHYL ESTER OF BENZOIC ACID	C13H16O3
14.43	85.64	462504	1-METHYL-2-(PROPENYLOXY)-ETHYL ESTER OF BENZOIC ACID	C13H16O3
14.59	94.89	301656	3,3'-Dimethylbiphenyl	C14H14
14.65	92.24	827682	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
14.71	95.2	165770	1,1'-Biphenyl, 3,4'-dimethyl-	C14H14
15.43	87.85	326461	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8