

## 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

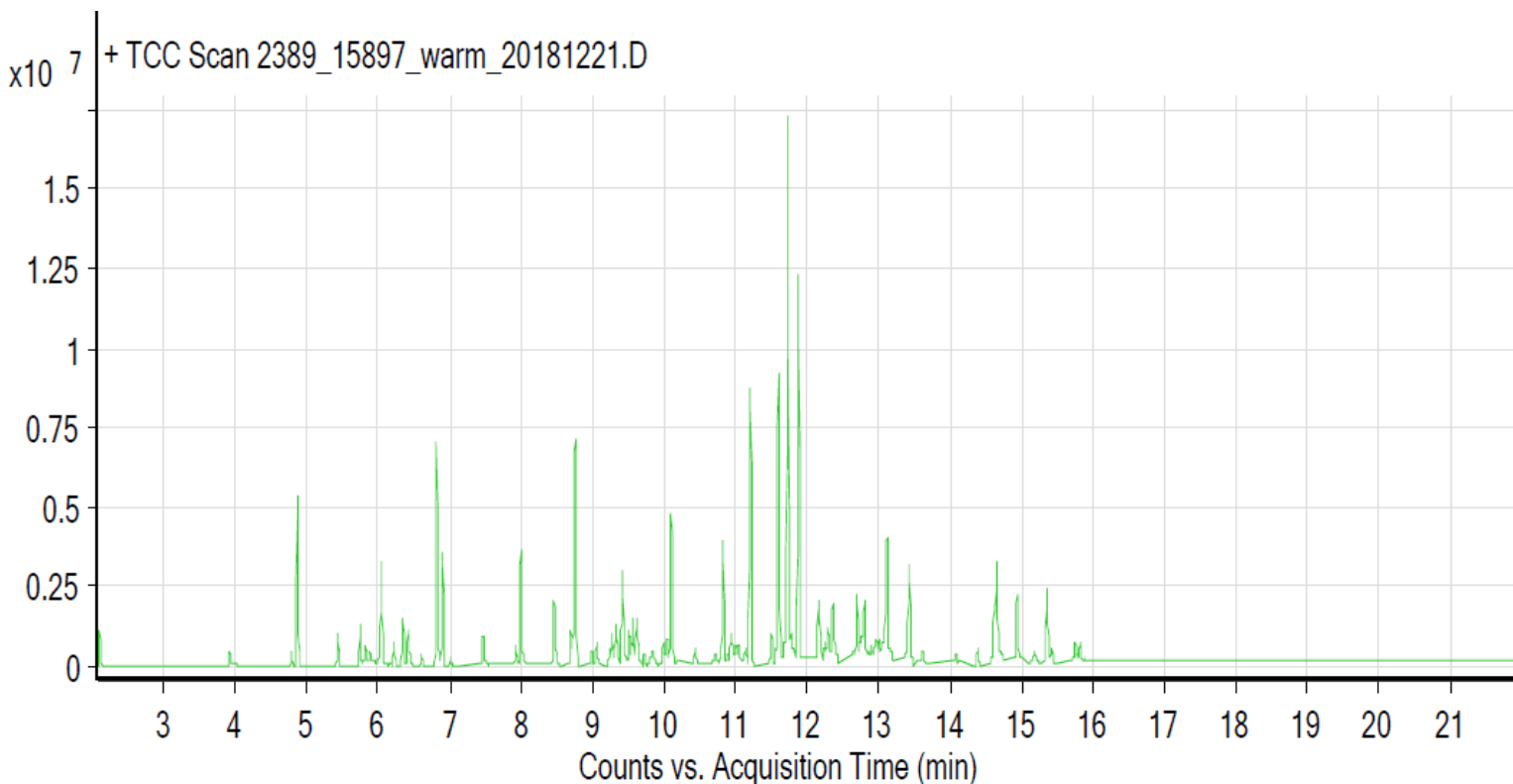
*Alkynes* – can become reactive when exposed to heat or UV light

Sample: Museum board by Peterboro; warm white

Date collected: 12/22/2018

Oddy test result: Unsuitable

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 cotrapped for 2 min at -15°C; GC ramped from 35°C to 225 °C at 7.5°C/min. Data analyzed in masshunter Qualitative. Samples > 90% match with a NIST 17.0 library are reported. VOCs not highlighted are because they were also observed in blanks: (1) 11.8 min: 2-methyl-, 3-hydroxyl-, 2,4,4-trimethylpentyl ester propanoic acid



### Compound Table

RT	Score (Lib)	Area	Name
3.98	91.97	536224	Benzene, 1,3-dimethyl-
4.87	97.46	7072119	Ethanol, 2-butoxy-
5.43	96.38	1436623	2-Propanol, 1-butoxy-
5.75	96.58	1871320	N-benzylidene-dimethylammonium chloride
6.22	93.35	1140800	Heptane, 2,2,4,6,6-pentamethyl-
6.41	93.73	1077308	Octanal
6.82	97.86	10515048	1-Hexanol, 2-ethyl-
6.84	91.06	695730	dl-Limonene
6.9	95.31	2669768	Benzenemethanol
7	92.52	537048	2-Pyrrolidinone, 1-methyl-
7.46	95.18	1519976	1-Octanol
7.92	90.51	1038315	Tridecane
8	96.58	5559696	Nonanal
8.48	94.68	808052	Pentanedioic acid, dimethyl ester
8.69	93.48	1664429	Acetic acid, 2-ethylhexyl ester
9.06	90.08	1062453	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./.-)-
9.27	93.16	1533978	Ethanol, 1-(2-butoxyethoxy)-
9.42	95.18	4967261	Undecane, 4,7-dimethyl-
9.51	95.28	1378974	Decanal
9.99	91.64	1176662	2-Ethyl-1-hexyl propionate
10.1	91.04	7845993	1-Phenoxypropan-2-ol

10.43	92.05	762916	1-Decanol
10.82	96.08	3894104	Undecane, 4,7-dimethyl-
11.04	91.61	632434	Decane, 2,2-dimethyl-
11.21	91.09	11459692	Cyclohexasiloxane, dodecamethyl-
11.73	94.95	28369301	Ethanol, 2-(2-butoxyethoxy)-, acetate
11.88	94.53	21301681	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.16	94.69	2922520	Eicosane
12.96	97.52	1757120	Tricosane
13.62	96.74	761575	Decane, 2,2-dimethyl-
15.36	95.73	3807542	Octane, 1,1'-oxybis-
15.75	91.99	1168727	Dodecane, 2,6,11-trimethyl-