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

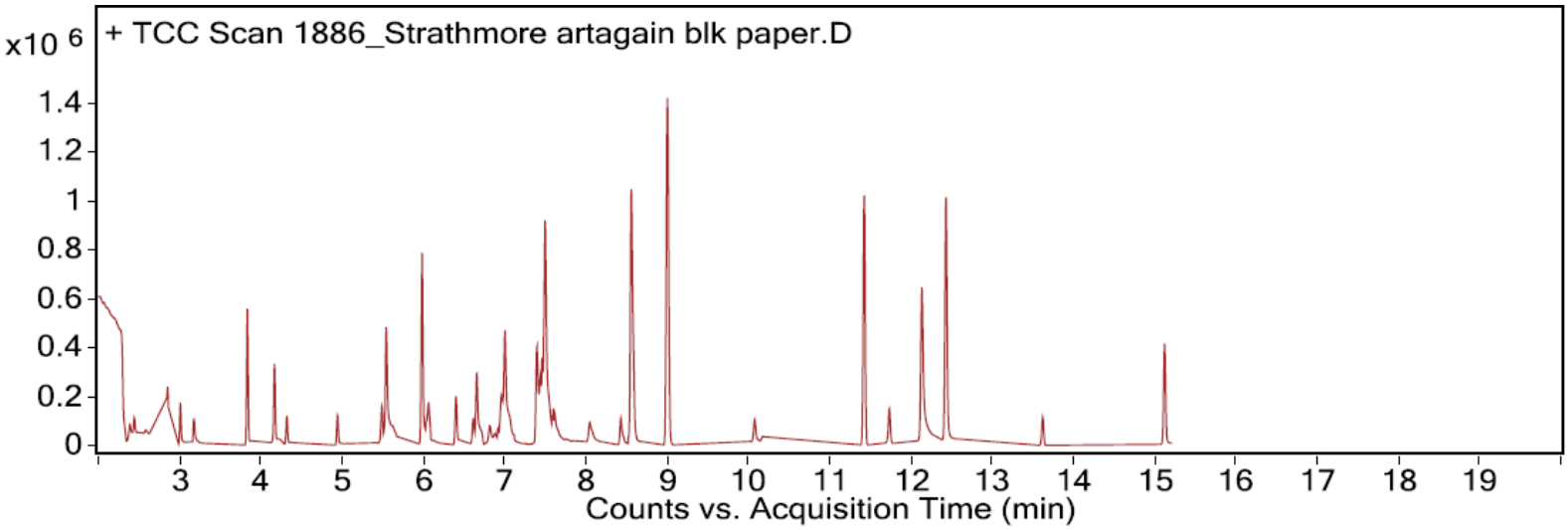
Sample: Dick Blick; Strathmore Artagain drawing paper coal black

Oddy test result: Permanent

Date collected: 12/12/2017

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) 12.1 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 12.4 min: 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.006	95.3	C4H10O	74.1	208662	71-36-3	1-Butanol
3.173	86.8	C2H8O2Si	92.0	217634	1066-42-8	Silanediol, dimethyl-
3.831	97.4	C7H8	92.1	726907	108-88-3	Benzene, methyl-
4.165	97.3	C6H12O	100.1	474340	66-25-1	Hexanal
4.317	94.1	C6H18O3Si3	222.1	180809	541-05-9	Cyclotrisiloxane, hexamethyl-
4.941	99.6	C8H10	106.1	184794	100-41-4	Ethylbenzene
5.485	91.5	C7H14O	114.1	156382	111-71-7	Heptanal
5.540	98.1	C6H14O2	118.1	881130	111-76-2	Ethanol, 2-butoxy-
5.981	97.2	C5H12O2	104.1	1292899	126-30-7	1,3-Propanediol, 2,2-dimethyl-
6.061	88.5	C7H16O2	132.1	182555	5131-66-8	2-Propanol, 1-butoxy-
6.399	98.9	C7H6O	106.0	380991	100-52-7	Benzaldehyde
6.612	98.5	C6H6O	94.0	229597	108-95-2	Phenol
6.654	95.5	C8H24O4Si4	296.1	614149	556-67-2	Cyclotetrasiloxane, octamethyl-
6.961	95.0	C7H8O	108.1	852738	100-51-6	Benzyl Alcohol
7.002	98.1	C8H16O	128.1	807797	124-13-0	Octanal
7.394	94.2	C8H18O	130.1	1057363	104-76-7	1-Hexanol, 2-ethyl-
7.439	92.6	C10H16	136.1	315894	138-86-3	dl-Limonene
7.495	86.2	C7H8O	108.1	1637301	100-51-6	Benzenemethanol
7.613	95.1	C8H18O	130.1	453773	7212-53-5	5-Methyl-1-heptanol
8.045	94.2	C8H18O	130.1	279827	111-87-5	1-Octanol
8.429	95.8	C8H8O2	136.1	247589	93-58-3	Benzoic acid, methyl ester
8.558	98.7	C9H18O	142.1	2232535	124-19-6	Nonanal
9.003	91.9	C10H30O5Si5	370.1	2915628	541-02-6	Cyclopentasiloxane, decamethyl-
10.075	96.0	C10H20O	156.2	194324	112-31-2	Decanal
11.426	91.3	C12H36O6Si6	444.1	1747287	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.733	97.3	C16H34	226.3	246741	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.133	93.2	C12H24O3	216.2	1604392	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.430	93.4	C12H24O3	216.2	1895950	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
15.122	91.8	C16H30O4	286.2	722537	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-