**Scientific Analysis of Fine Art Report #1180:** Kiribati Bottle Residues and Their Comparison to Campana Italian Balm Residues and the IRUG (Infrared and Raman User's Group) Spectral Database

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**Object Description, Reason for Analysis:** The object submitted for analysis, artifact 2-8-s-2a, is the bottom fragment of a colorless glass bottle. The shape of this bottle fragment is consistent with the shape of the bottles used to hold Campana Italian Balm, a lotion that was the best-selling hand lotion of the 1930s.

The fragment contains two dark brown residues and one white residue in its base, as well as a reddish-brown residue near the top. The FTIR spectra from these residues were compared to those from a non-archaeological and partially filled bottle of Campana Italian Balm conducted by the Evans Analytical Group (David Saperstein, PhD Scientist, FTIR, GCMS and Raman Services).

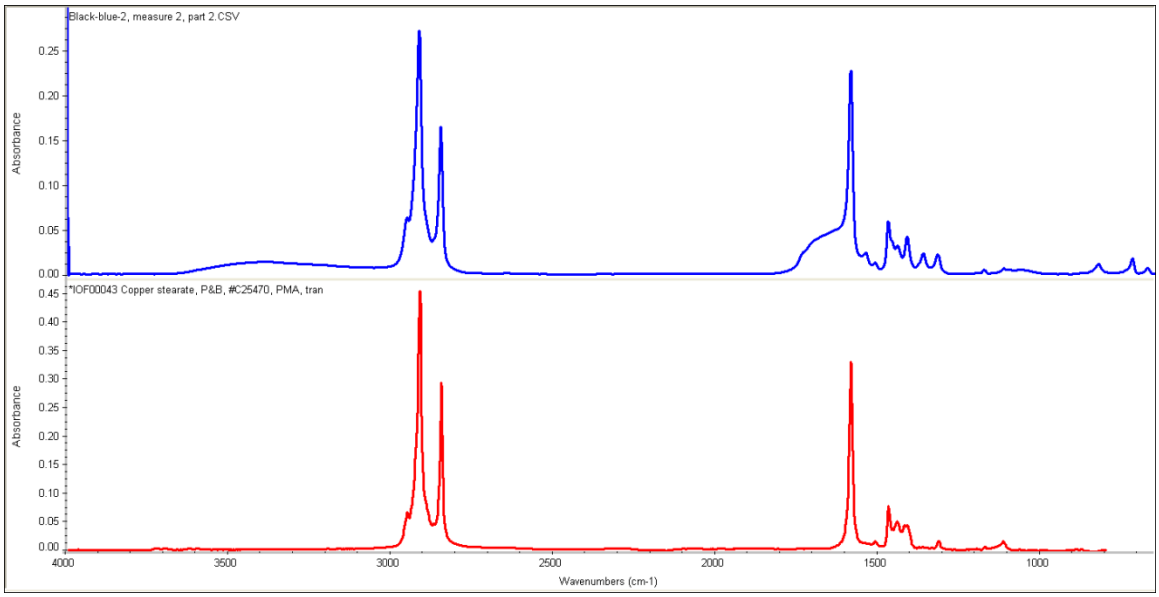
As noted in Saperstein's report, one report on the composition of Campana Italian Balm has been published (see Appendix A):

**Analytical Protocol:** Transmission Fourier transform infrared spectroscopy was conducted on each sample using a Thermo 6700 FTIR bench, a continuum microscope, a 4 $cm^{-1}$ spectral resolution, and a 4000-650 $cm^{-1}$ spectral range. Each spectrum represents an accumulation of 128 scans.

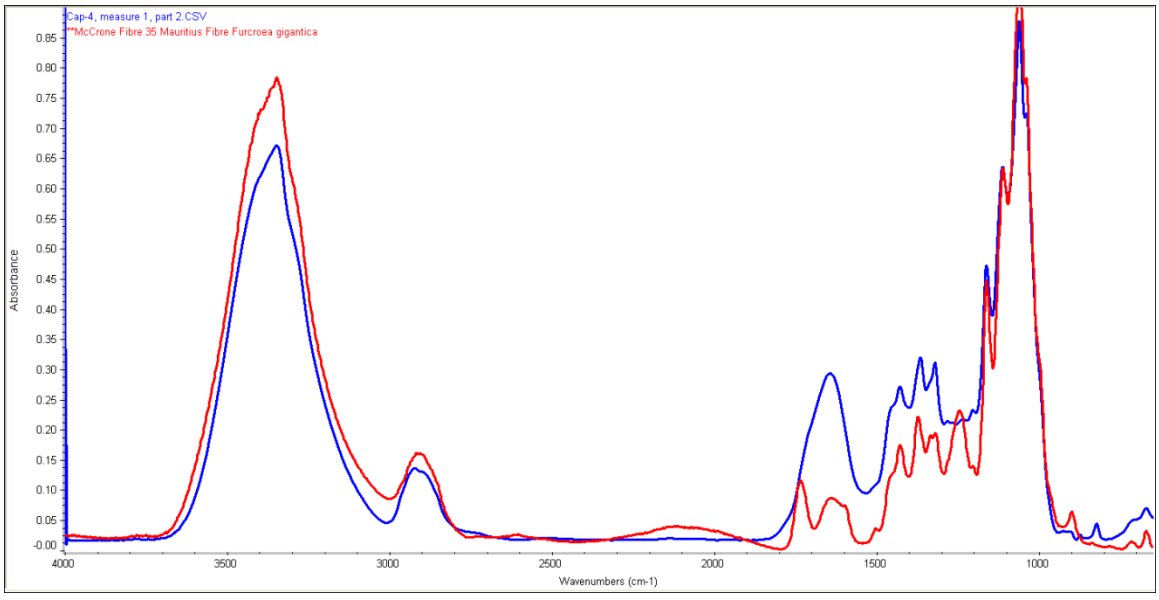
**Findings:**

Two of the spectra from EAG labs were re-analyzed using the IRUG and related commercial databases at Winterthur to test the protocols used by both laboratories. The black-blue material was found using our searching protocol to be a metal stearate such as copper stearate, similar to the conclusions drawn by EAG. EAG notes that copper stearates are typically green, but photodegradation of copper compounds can cause them

to turn brown or black over time. This is commonly observed in copper-based pigments in works of art. See Figure 1 below.

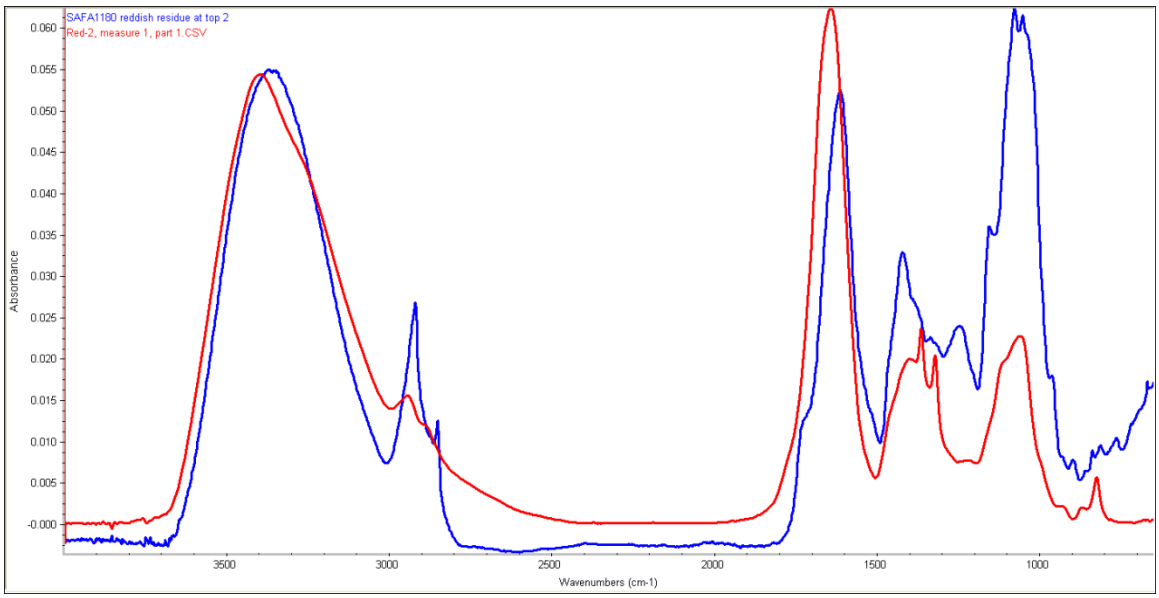



The cap data from EAG was also analyzed using Winterthur's protocols and databases, and again we reach the same conclusion as EAG – the material is cellulose, and as such may represent a fragment of a paper liner from the interior of the cap. See Figure 2 below.

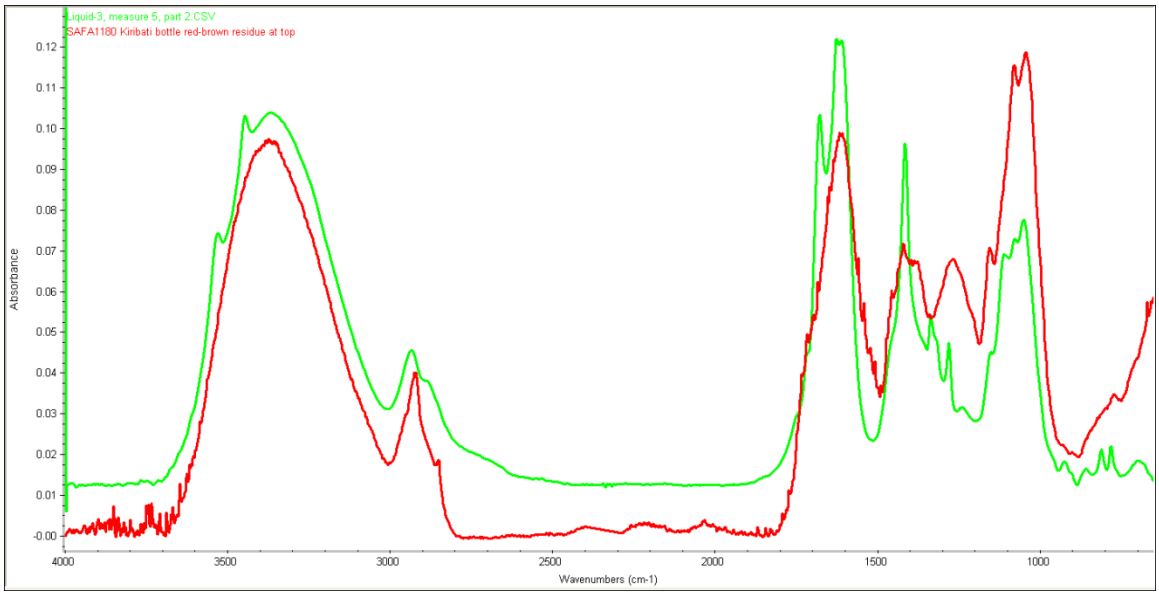



The reddish residue identified both in the non-archaeological bottle and in Kiribati fragment 2-8-s-2a was found to be cellulosic in nature (predominately based on the O-H stretching band ~3500 $cm^{-1}$ and the bands between 1050 and 1100 $cm^{-1,}$ as well as the carbonyl band ~1700 $cm^{-1}$ and several other bands in the fingerprint region between 1500

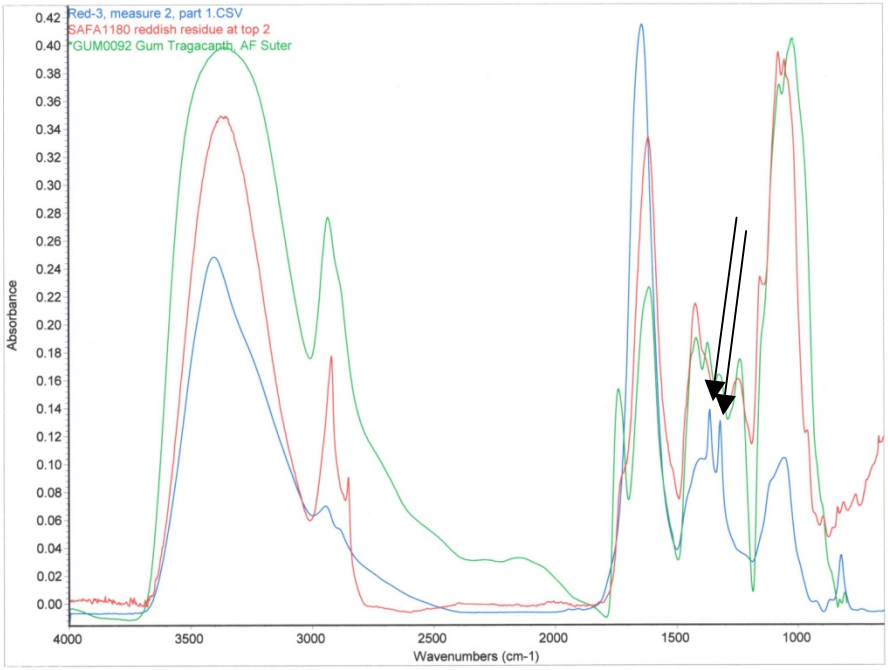
and 1000 $cm^{-1}$, see Figure 3 below), which could suggest the presence of residual gum tragacanth. Gum tragacanth was one of the ingredients listed for Campana Italian Balm in a 1957 toxicology manual (see Appendix A).




Similarly, the brown residue in the bottom of the bottle appears to be cellulosic in nature (see Figure 4 below).




There are additional bands in the sample from the intact bottle that are not in the cellulose reference spectrum, however, suggesting that there may be an additional component in the Kiribati sample beyond a plant gum such as gum tragacanth (see Figure 5 below).




Note for example the two sharp peaks in the "fingerprint region" of the spectrum from the intact bottle that are not present in either the gum tragacanth reference spectrum or in the reddish residue from the Kiribati bottle.

Figure 6 below, which compares two spectra from the dark brown residue on the Kiribati bottle's bottom to a spectrum from hemicellulose, also clearly reveals the cellulosic nature of this residue.

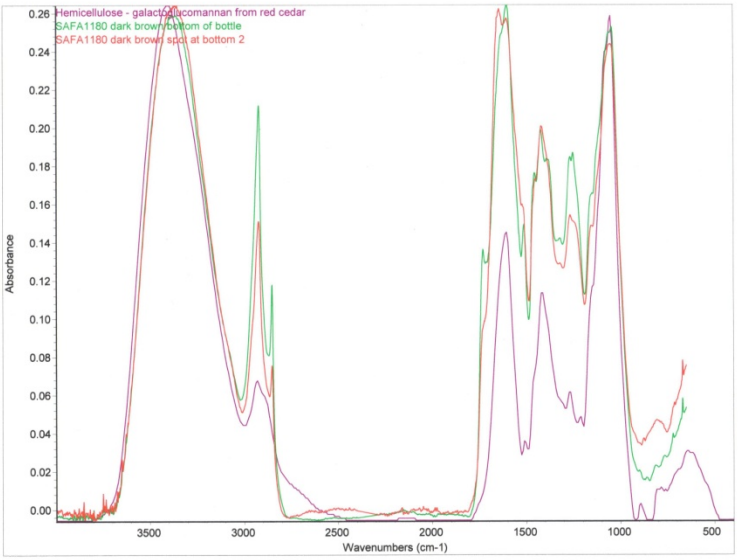
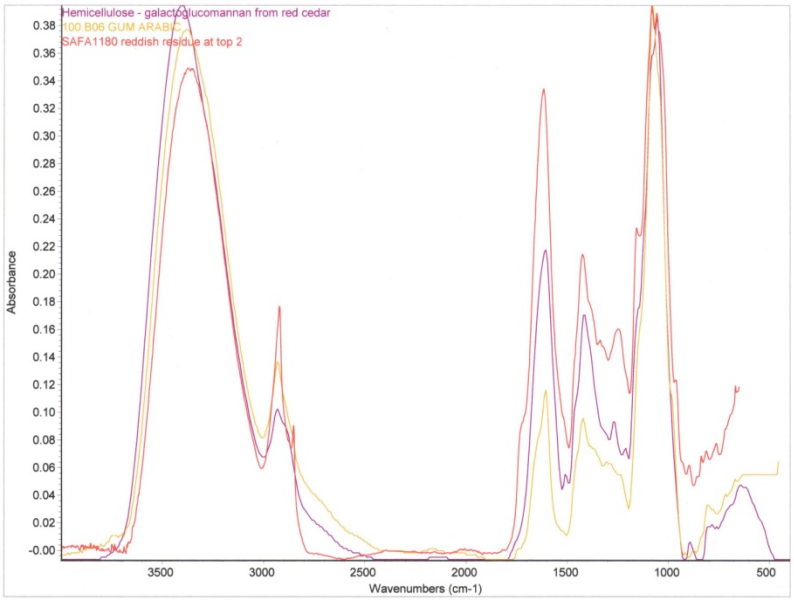


Figure 7, shown below, reveals a favorable comparison between gum Arabic and the reddish residue in the Kiribati bottle. However, FTIR is insufficient to distinguish between different types of plant gums, and gas chromatography-mass spectrometry is necessary to definitively distinguish between gum tragacanth and gum Arabic.




**Discussion and Conclusions:** The FTIR databases at Winterthur Museum's Scientific Research and Analysis Laboratory, including the Infrared and Raman User's Group database, which has at least 55 plant gum spectra, were used to compare the FTIR assignments made by the Evans Analytical Group for four different residues from a Campana Italian Balm bottle, a blue-black residue, a second residue from under the cap, a reddish residue from the side of the bottle, and a brown residue. The blue-black residue was confirmed to be a metal carboxylate, likely a copper stearate "soap" and the cap residue was found to be cellulosic, likely due to a paper liner under the cap. The reddish residue and the brown residue were likewise found to be cellulosic. New FTIR spectra were also acquired from the Kiribati bottle fragment, a dark brown residue in the bottom of the bottle, a red residue on the bottle fragment's side, and a red-brown residue on the bottle fragment's side. All of these new spectra were cellulosic in nature, suggesting again the gum component listed in Campana Italian Balm's ingredient list (EAG's report #2 describes the Gum tragacanth reference spectrum and its similarities to artifact and intact bottle residues). Different species of plant gums cannot be fully distinguished by FTIR, and so a definitive assignment as gum tragacanth would require gas chromatography-mass spectrometry. Since gum tragacanth was not identified in the Campana Italian Balm formula until the 1950s, however, an identification of the residues as a different type of plant gum, such as gum Arabic, may still be consistent with the Kiribati bottle fragment having held Campana Italian Balm.

**Appendix A:**

| Ingredients list for Campana's Italian Balm Cosmetic in *Clinical Toxicology of Commercial Products* by Marion N. Gleason, 1957, published by Williams and Wilkins |
| --- |
| Essential oils |
| Alcohol |
| Phenol |
| Benzoic Acid |
| Gum Tragacanth |
| Glycerin |
| Sorbitol |