Frontier Analysis, Ltd

TECHNICAL SERVICE RESPONSE NO.: UT084

Subject: Analysis of a Fragment near the Roswell Crash Site (Event Date: Approximately 2-3 July 1947)

Date: July 7, 2014

Requested By: Frank Kimbler
Roswell, NM

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Background/Objective:

A small fragment with a 'black' side and a red side was found 1,000 feet southeast of the main Roswell 1947 crash debris field. There is nothing manmade, not even a road, for at least ½ mile in every direction from where the fragment was found. Previous SEM-EDS analysis was submitted with this sample. Detected were Al, Si, Mg, Ca, Fe and Ti. Ti was only detected on the red side of the sample. The object is to determine the composition of the fragment.

Conclusions:

●The sample is covered with typical environmental debris. It is a non-homogeneous mix of primarily clay mineral (montmorillonite/smectite like), quartz mineral (sand), calcite (calcium carbonate), protein derived material (mold, bacteria and/or animal origin) and possibly plant derived products.

●The elemental analysis of Al, Si, Mg, Ca and Fe reported above are typical of elements found in dirt/soil.[1] Ti is sometimes found in dirt, but it can also be from a paint additive.

●The fragment is very brittle and composed of mostly an epoxy resin ester based on bisphenol-A with a quartz filler. It has red paint which is a polyacrylate/styrene copolymer with a kaolinite-like filler. There may be another coating under the red paint

[1] Hasford T. Shacklette and Josephine G. Boerngen, , "Elemental Concentration in Soils and other Surficial Materials of the Conterminous United States", U.S. (Geological Survey Professional Paper: 1270), United States Department of the Interior, 1984. http://pubs.usgs.gov/pp/1270/pdf/PP1270_508.pdf

composed of an alkyd resin and calcite filler. Additionally, on the 'black' side, olivine is on the surface. The olivine could be part of the fragment, though an environmental debris source cannot be ruled out. Materials like these are used as insulating components for the electrical and electronic industries, for aircraft and automobile components, machinery and chemical apparatus.[2]

●Bubbles observed in the resin show the fragment has been exposed to heat. It is not known whether or not this occurred as part of a manufacturing process.

●There is a small amount of protein-type material in the resin. This may indicate mold/bacteria have established a presence on/in the fragment.

Procedure:

Sample: The sample was received on May 23, 2014 in a small resealable plastic bag, that was in turn enclosed in a plastic "Whirl-Pak" bag. It weighed 0.1504 grams. The fragment is irregularly shaped, measuring approximately 11 x 5 x 9 x 7 mm on its sides (see photograph on page 3). It's 1.42 mm thick as measured by a digital micrometer.

FT-IR spectra were obtained from both sides of the sample 'as received'. The surface material was scraped away from both sides and additional spectra were obtained. In addition to the sides, spectra were also acquired of scrapings from the edge of the sample. All FT-IR (Fourier Transform-Infrared Spectra)[3] were acquired on the Thermo Electron Avatar 360 spectrometer, using the Smart Herrick diamond sampling accessory. Microscope photographs were taken of both sides of the sample 'as received', then again after debris removal, and additionally the edge. They were acquired using a Canon A520 digital camera interfaced to a Leica GZ6 stereomicroscope.

Results:

The detailed results of the individual tests done on the fragment follow. These results are summarized in the conclusions section on the pages 1 and 2 of this report.

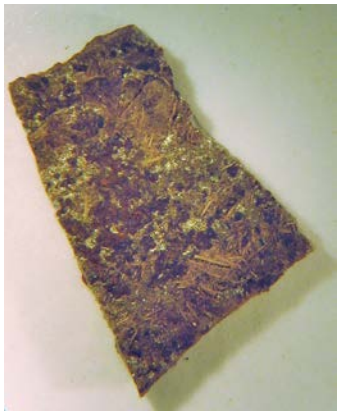
The Black Side of the Fragment

Microscopic examination of the fragment 'as received' shows environmental debris. Vegetation particulates as well as dirt/soil are observed. This identification was confirmed by infrared analysis below. The area, cleaned of 'dirt', reveals a light gray material that has a melted-appearing surface, indicating heat exposure. It is not known

[2] http://en.wikipedia.org/wiki/Epoxy
[3] **FT-IR (Fourier Transform Infrared Spectroscopy):** Infrared spectroscopy is used for the molecular structure identification and quantification of solids, liquids, and gases. An infrared spectrum is the result of light (in the 2 to 25 micron wavelength range) interacting with the vibrations of molecules. The particular set of vibrations of a molecule gives rise to specific spectral absorption bands, often referred to as the "fingerprint" spectrum.

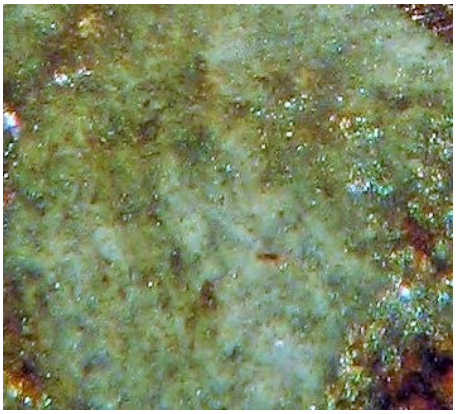
whether or not this occurred as part of a manufacturing process. There is a reddish substance in the crevices of the gray substance. The fragment is very brittle and broke on cleaning, which is why it has a different shape. The magnification is also more than the 'as received' photograph. The microscope photographs follow.

Microscopic Pictures



Black Side
'As Received'

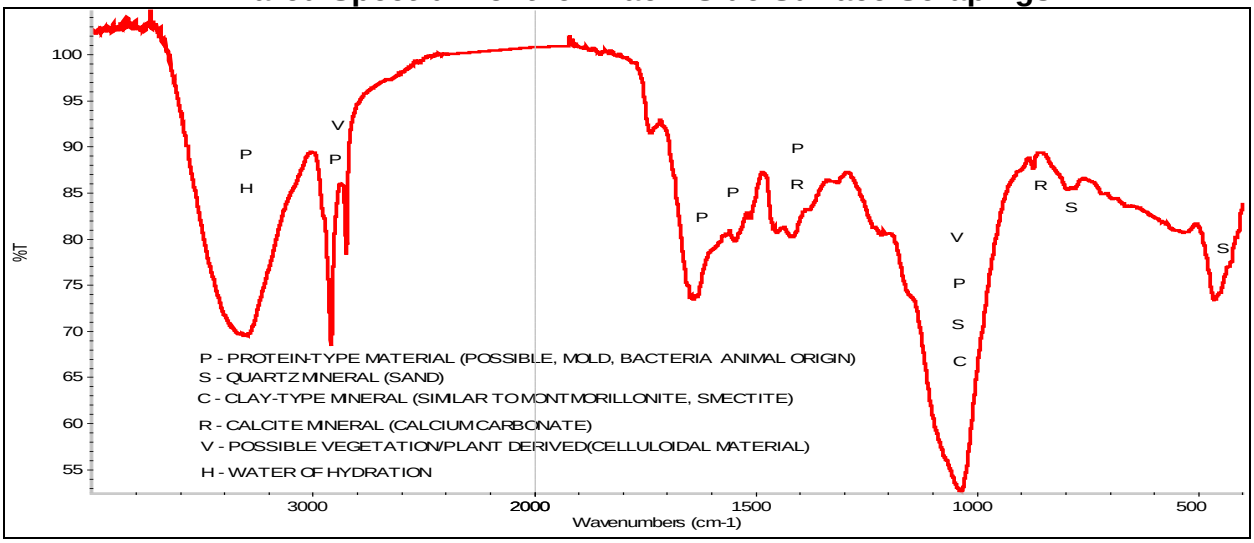
Black Side
Surface Cleaned



Clean Gray Area
Higher Magnification

Infrared analysis of scrapings from the surface of the fragment reveals typical environmental debris such as dirt/soil, protein derived material, and possibly some vegetation. Specifically detected are inorganic minerals such as clay (montmorillionite/smectite-like), sand (quartz) and calcite (calcium carbonate). The origin of the protein-type material is most likely mold, bacteria and/or animal. The spectrum follows, labeled with the peak identifications.

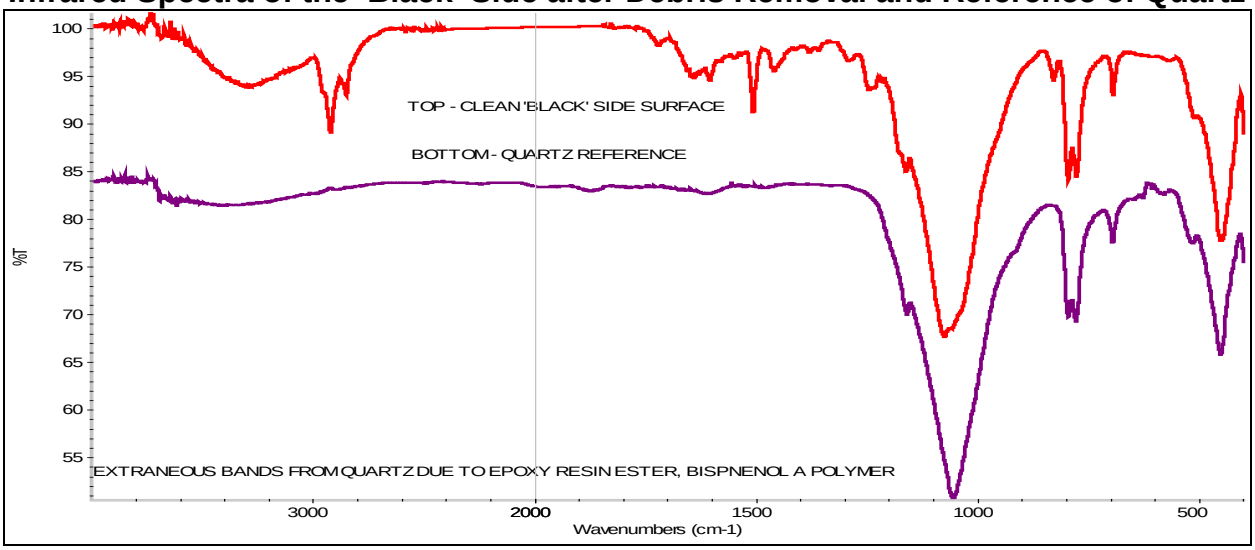
Infrared Spectrum of the 'Black' Side Surface Scrapings



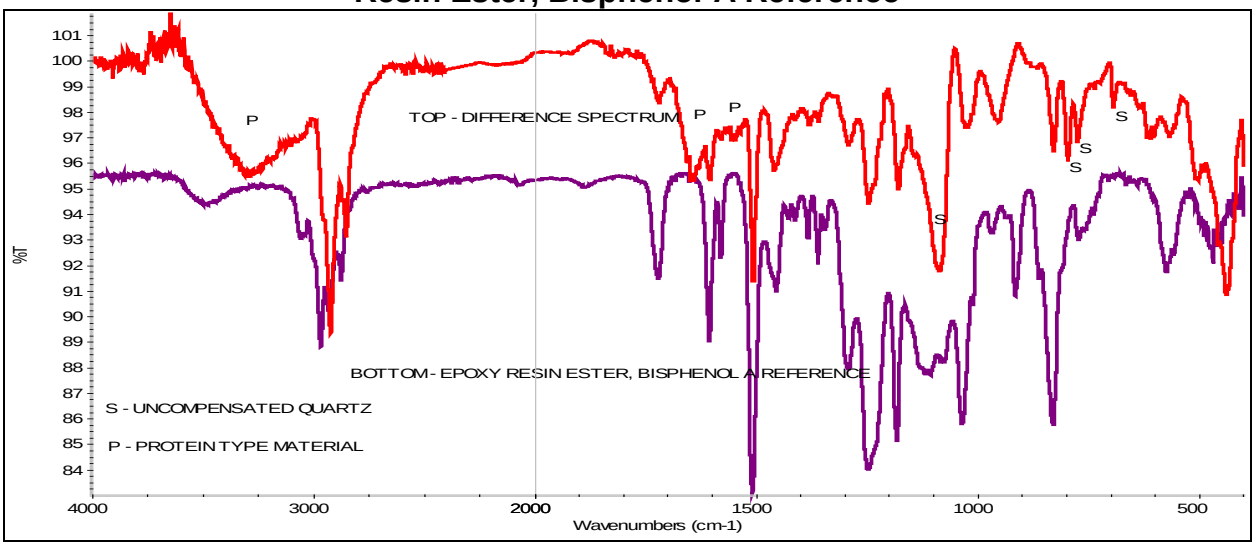
An infrared spectrum of the gray surface of the 'black' side, after much of the debris was removed, reveals an epoxy resin ester based on bisphenol-A with a quartz filler.

Additionally a small amount of protein-type material is detected. A speculation is that possibly mold/bacteria had established itself on the fragment. A difference spectrum was generated between a surface spectrum and a quartz reference to partially remove interfering quartz absorption. This procedure enhanced and revealed more bands of the resin which helped to facilitate its identification. The bands in a reference spectrum of epoxy resin ester, bisphenol-A match those in the difference spectrum, confirming its identification. Following are spectra of the gray surface material, along with a quartz reference, and the difference spectrum plus a reference spectrum of the epoxy resin ester, bisphenol-A.

Infrared Spectra of the 'Black' Side after Debris Removal and Reference of Quartz



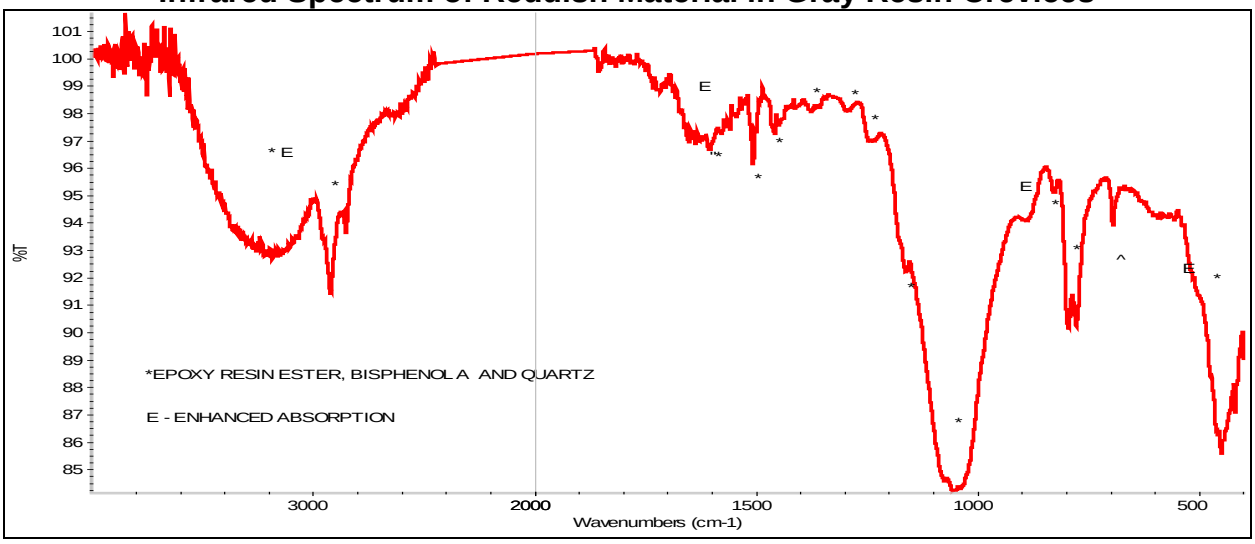
Infrared Spectra of the Difference (Clean 'Black' Side versus Quartz) and Epoxy Resin Ester, Bisphenol-A Reference



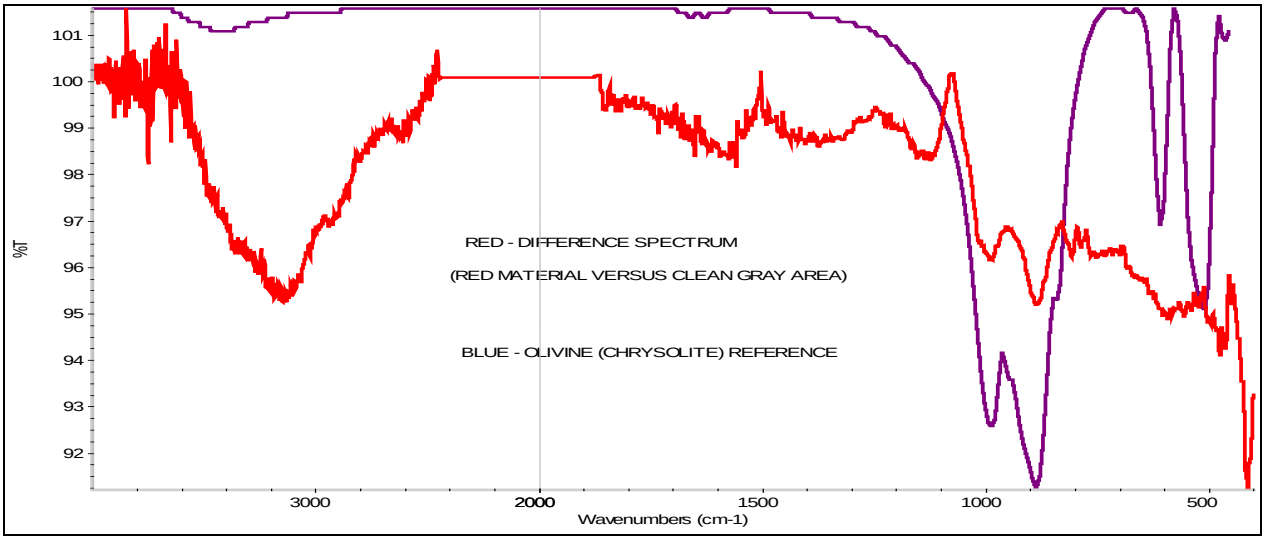
An infrared spectrum of a reddish material that remained in crevices of the gray resin after much of the debris was removed expectedly shows absorption due to the resin, but

an additional band is also observed at 884 cm^{-1}. A difference spectrum generated between that of the red material versus the clean gray material enhanced absorption and revealed additional bands that were identified as belonging to olivine (chrysolite). It is unknown whether olivine is part of the fragment formulation or more environmental debris. Following are spectra of the red material, the difference spectrum, and olivine reference for comparison.

Infrared Spectrum of Reddish Material in Gray Resin Crevices

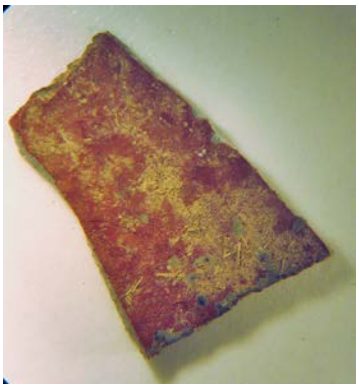


Infrared Spectra of Difference (Reddish Material versus Clean Gray Material) and Olivine Reference

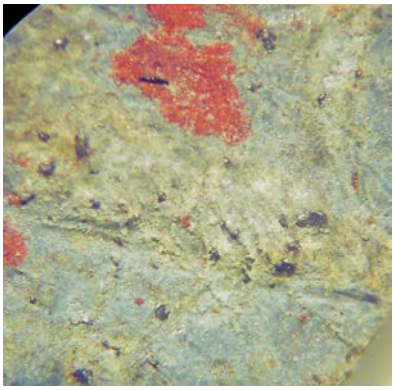


The Red Side of the Fragment

Examination of the ‘as received’ red side of the sample under the microscope expectedly shows environmental debris (dirt/plant fragments) like the black side. Removal of the debris clearly displays the remnants of a red coating. Some paint was removed to observe the material under the paint. It is gray with bubbles, indicating heat exposure. Following are the photographs.

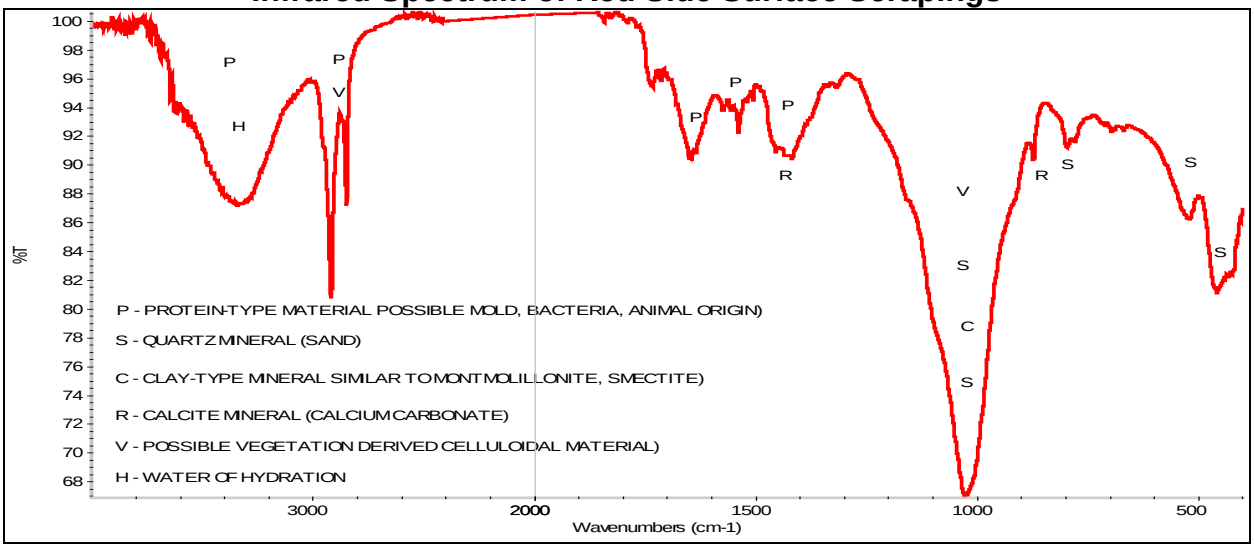

Red Side “As Received”


Red Side Surface


Some Paint Removed
Higher Magnification

Infrared analysis of scrapings from the ‘uncleaned’ surface of the fragment shows the same environmental debris as noted in on the ‘black’ side, though band ratio variances suggest a difference in a quantitative mixture. Specifically detected are clay, sand, calcite, a protein-type substance and possible plant derived material. Following is the spectrum.

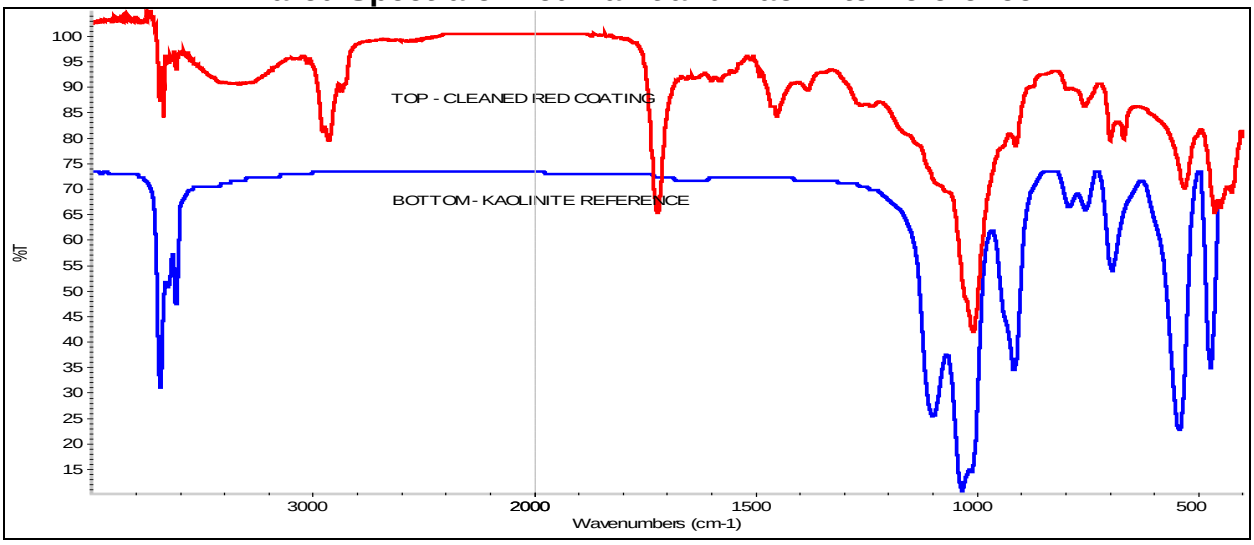
Infrared Spectrum of Red Side Surface Scrapings



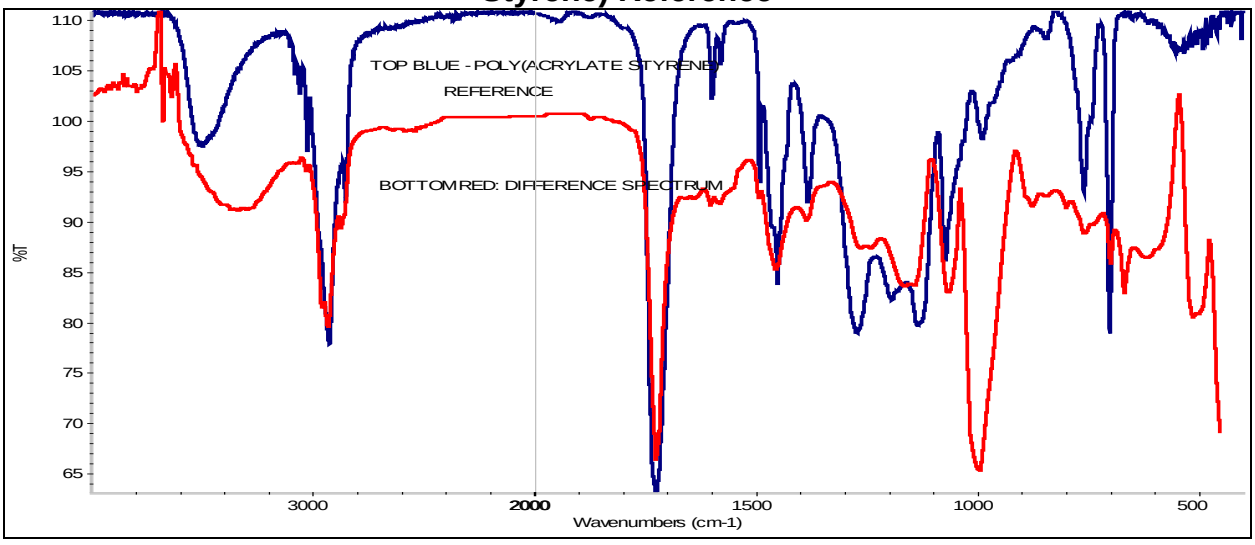
Infrared analysis of the red paint after cleaning clearly reveals it is composed of a poly(acrylate styrene) copolymer and a kaolinite-type mineral filler. The kaolinite masks

much of the polymer absorption. Therefore, a difference spectrum was generated to diminish this effect and enhance and reveal new bands from the polymer. The difference spectrum clearly displays bands matching a reference of poly(acrylate styrene),confirming its identity. Following are spectra of the red paint with a kaolinite reference and the difference spectrum with a poly(acrylate styrene) reference.

Infrared Spectra of Red Paint and Kaolinite Reference



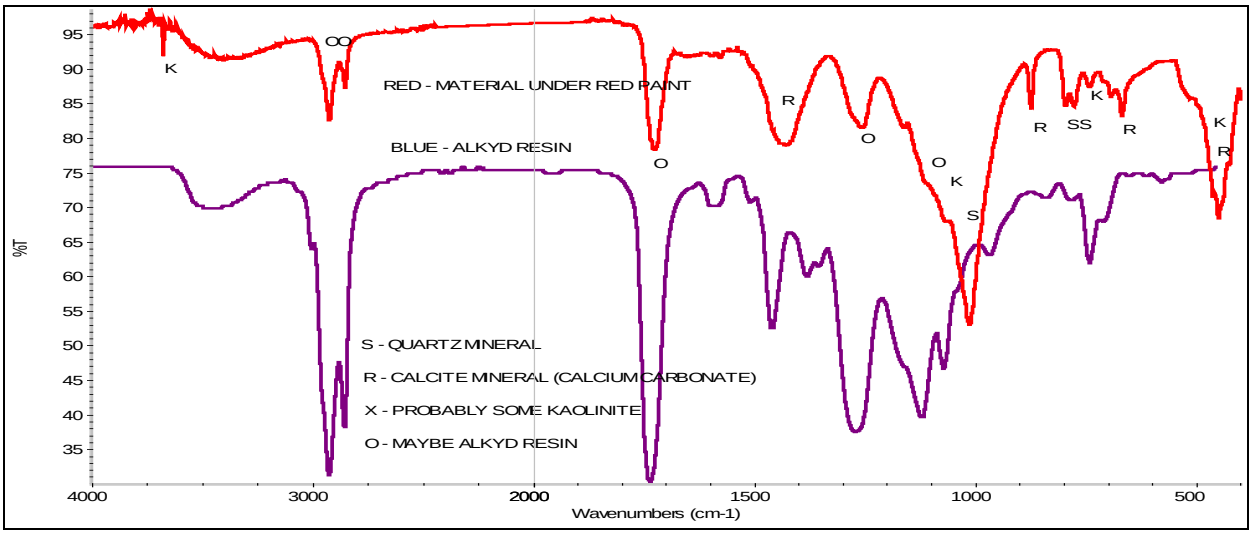
Infrared Spectra of Difference (Red Paint Versus Kaolinite) and Poly(acrylate Styrene) Reference



The paint was scraped from the surface, not only to see the appearance underneath (see above), but also to determine if and what was in between the paint and resin layer. An infrared spectrum taken of the gray area after paint removal suggest it is a combination of some resin components detected on the black side and some paint components. Detected are quartz mineral and probably kaolinite. Additionally, there is calcium carbonate which is not believed to be part of the ‘dirt’, because it is in between

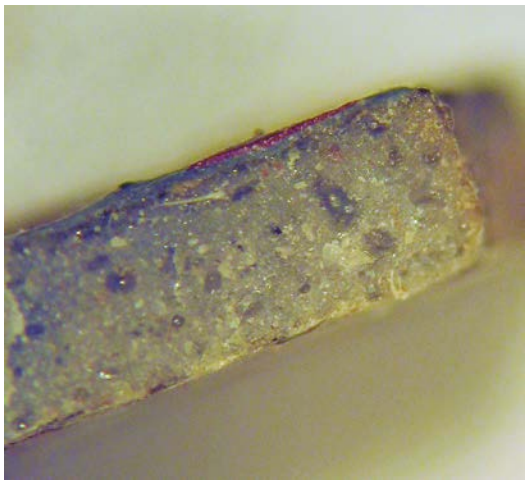
the paint and resin. Also, there may be an alkyd resin which could be a paint component. This may indicate the surface was covered with another coating before application of the red paint. Following are spectra of the material underneath the red paint and a reference of alkyd resin for comparison.

Infrared Spectrum of the Material underneath the Red Paint and Alkyd Resin Reference



The Edge of the Fragment

A microscope photograph of the edge of the fragment displays a thin red edge from the paint, and the main resin/quartz portion. Bubbles are observed again, clearly showing the fragment has been subjected to heat. The photograph follows.

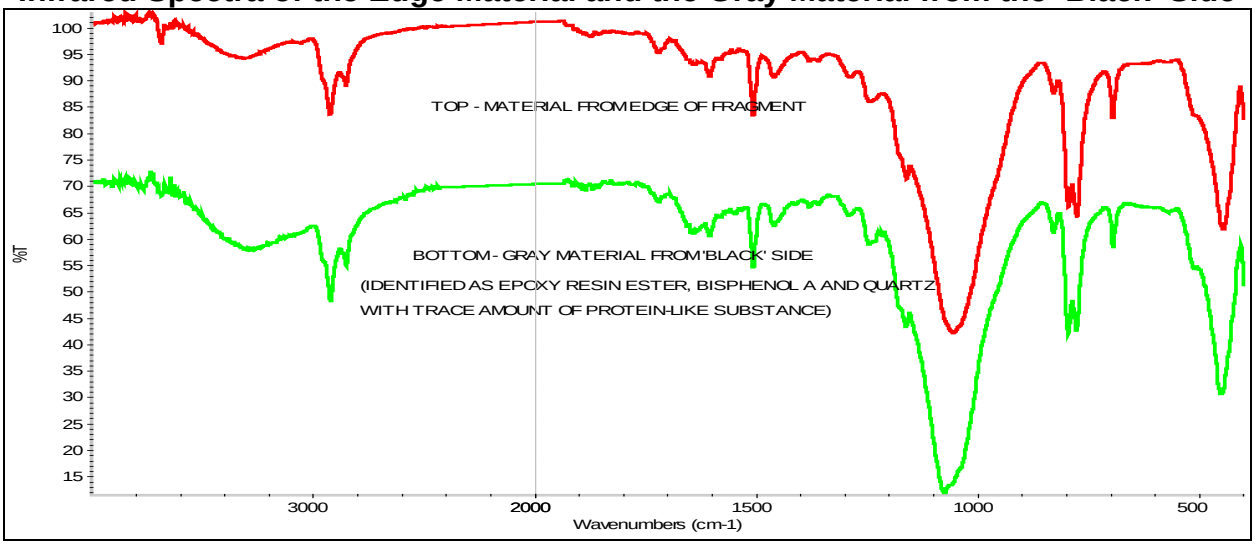


Fragment Edge

The infrared spectrum of the edge of the fragment matches that of the gray material from the cleaned 'black' side. Therefore the same interpretation applies. (See page 4)

In summation, the material is composed of an epoxy resin ester based on bisphenol-A with a quartz filler. A small amount of protein-type material is detected. Following are spectra of the edge material and the cleaned gray material from the 'black' side for comparison.

Infrared Spectra of the Edge Material and the Gray Material from the 'Black' Side



File: UT084

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