Robin Ohern

UCLA / Getty Master's Program
In the Conservation of Archaeological and Ethnographic Materials

On the Surface:
A Cultural and Scientific Analysis
of the Applied Surface from Two West African *Komo* Masks

Abstract

Komo masks from West Africa are known for their complex and fragile surfaces accumulated as a consequence of ceremonial use. This examination begins with the cultural context for the masks and a review of the ethics of performing research on these objects found in museum collections. Additionally, conservators at thirty museums in both the U. S. and Europe with *Komo* masks in their collections were surveyed to gather information on the history of *Komo* mask treatments and current conservation approaches. Samples from the surface of one *Komo* mask were analyzed using polarized light microscopy, X-ray fluorescence, and X-ray diffraction to compare with samples of possible materials applied to the masks, which include kola nuts, millet flour, blood, clays, crushed bone, and plant gum. Cross-section samples are investigated using Fourier transform infrared spectroscopy and scanning electron microscopy – energy dispersive X-ray spectroscopy to map the locations of organic and inorganic components. Preliminary results will be described.

1. Introduction

Komo (alt. Kòmò) masks are power objects that belong to *komo* associations in West Africa. Their wooden form is decorated with horns and quills and the surface is coated with a mixture of materials. Objects with applied surfaces, such as the mask shown below (Figure 1), present particular issues for a conservator tasked with their treatment. What materials make up the surface of the mask? What cultural or ethical issues should be considered? These questions have received limited investigation within museums so far. This presentation will attempt to provide answers to questions about culture, ethics, and surface composition. While I know that my title promised you two West African *komo* masks, I will only be presenting information on one of them today.

I am going to begin by introducing you all to the mask that I will be discussing during this presentation. I will then cover the conservation history of *komo* masks and current approaches to their treatment. Next, I will introduce the cultural context of the masks and the ethical issues of my research, leading into the technical study of the surface. For this presentation, I will use the terms mask and headdress interchangeably, keeping in mind that in its original context, the object was just the head of a full costume.

The *komo* mask (Figure 1) from the Fowler Museum at UCLA (X86. 385, L: 68.5 cm, W: 21.7 cm, H: 24 cm) has an underlying wooden form with the elements typical of such horizontal masks: a rounded head, an elongated mouth, and two large horns at the back (McNaughton 1991). The mask fits on the wearer's head like a baseball cap (Gagliardi 2010). The wooden form has porcupine quills, feathers, cloth and animal horns attached to it by cords and metal nails.

Figure 1: *Komo* Mask (X86.385) from the Fowler Museum. Dimensions: X86. 385, L: 68.5 cm, W: 21.7 cm, H: 24 cm

The surface of the masks, including a large portion of the quills and horns, is covered with a dark brown encrustation that is thicker on the top of the mask than on the sides. The material has developed a craquelure pattern and there are many areas of loss that reveal the wood beneath. This surface encrustation has a uniform distribution of small plant fibers, as well as a few larger plant fibers and leaves, as shown in the images below (Figure 2).

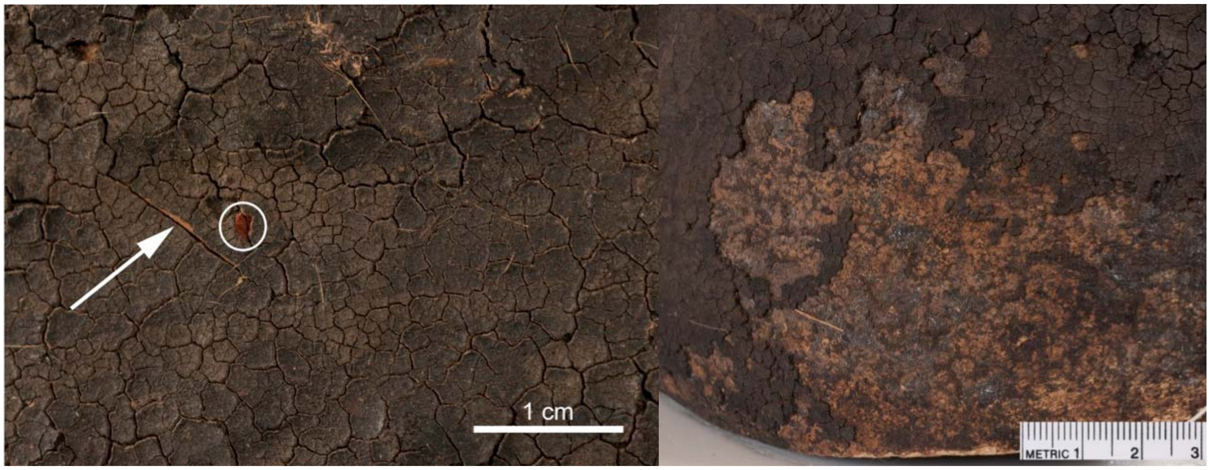

Figure 2: Details of the surface from X86.385. Left image shows a red particle (circled) and a plant fiber (arrow) embedded in the surface. Right image shows an area of loss that reveals the wood beneath.

2. Conservation Survey

In order to better understand the history of conservation for these masks, a survey was sent out to thirty museums with a total of thirty-nine *komo* or *kono* headdresses. *Kono* headdresses have similar surfaces and are from the same geographic area, but belong to a different power association. Almost sixty percent of the museums contacted responded to the survey.

Number of masks in collections:	39
Number included in responses:	22
Percent of masks in the results:	**56%**

Based on the results, less than half of the masks had conservation records (Figure 3). Aside from the two objects in my thesis, only one headdress had been analyzed with x-radiography. Documented techniques and materials used to stabilize the applied surface in the past include Gelatin, Klucel, Lascaux, Methyl cellulose, Paraloid B-72, Paraloid B-67, and PVAC. Paraloid B-72 is the only material used on more than one object.

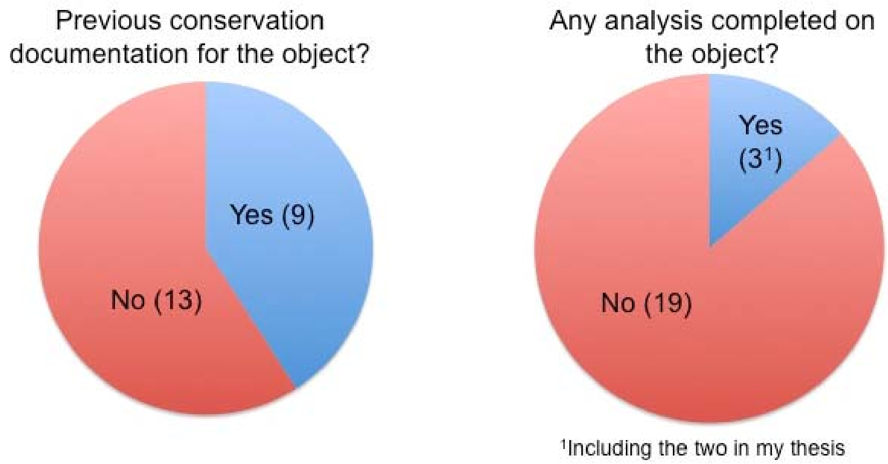

Figure 3: Two graphs of the survey results.

The variety of consolidants may suggest that the applied surface does not consistently behave the same way to the same materials. The choices tend to be fairly conventional and commonly used materials in conservation. This indicates that treatment approaches to the masks tend to be similar to those used for other—potentially unrelated—materials. Additionally, the objects may have undocumented surface treatments, such as the image below (Figure 4) from the *komo* mask I investigated.

Figure 4: Examples of undocumented treatments identified with the white rectangles on X86.385.

Besides surface treatments, the objects have received other interventions. These interventions include removal of insect casings, reattachment of feathers, reinforcement of quill bundles, and stabilization of the wood structure. In general, there does not seem to be a component of *komo* masks, aside from the surface, that consistently requires treatment across collections.

When asked what information conservators would want before beginning treatment, the responses emphasized conversations with the curator about the cultural context and material identification. Most respondents would only conduct surface stabilization if absolutely necessary and were very unwilling to conduct loss compensation.

The survey of the conservation approaches to *komo* masks reveals a lack of scientific investigation, a variety of treatment approaches, an interest in the surface materials and cultural context, and, perhaps most strongly, the importance of the dialogue between curator and conservator when caring for museum collections.

3. Cultural Context: *Komo* associations

So, what is a *komo* power association? One way to answer that question is with a cultural attribution. The *komo* power association is often attributed to the Bamana, or the larger Mande cultural group shown below on the map in pink (Figure 5). However, recent research suggests that the *komo* power association transcends cultural boundaries and should not be limited to just one particular group within the area marked on the slide (Gagliardi 2010: 14; Diamitani 2008; Diamitani 1999; Colleyn 2009; Jespers 1995).

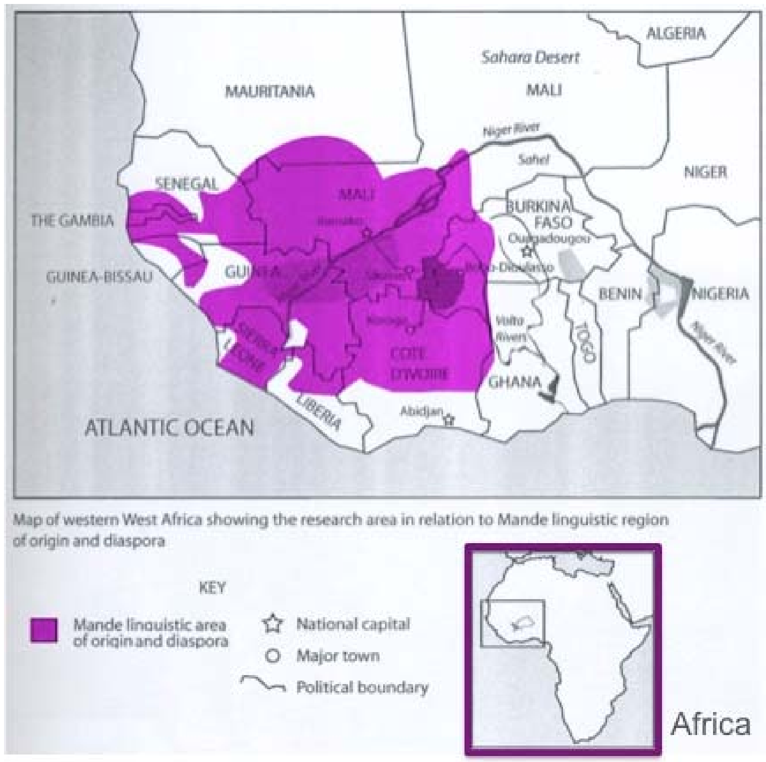

Figure 5: Image of the location for the Mande linguistic area, with whom the *Komo* association is often attributed. (Illustrated by Michael Johnston in Gagliardi, 2010, altered by R. Ohern)

In terms of what power associations do, they "work to address daily concerns, monitor people's behavior, and control exceptional energy" (Gagliardi 2010: 67). The associations have religious, political, judicial and philosophical responsibilities within their community (McNaughton 1979: 3; Colleyn 2009: 25-26).

Komo associations accumulate and control energy and power, which can be used either for good or bad. The power is employed to combat criminals and sorcerers, and manipulate the potent energy found in nature (McNaughton 1979: 9-10; in Gagliardi 2010: 70, 72). Objects are essential for the association's ability to wield and gather power (McNaughton 1979: 9-10; in Gagliardi 2010: 70). Therefore, each part of the creation of a *komo* mask involves processes designed to invest the object with energy: such as, the act of sculpting, the initial materials, and the application of substances over its life time (Imperato 2009: 151).

During their manufacture, Blacksmiths carve the headdresses out of wood and attach quills, vulture feathers, cloth and antelope horns. While there is probably a significant variation in the process of applying the surface, there is a general procedure (Figure 6). The application begins with a layer of crushed plant bark and root that creates a viscous paste. The paste sticks strongly to the wood of the mask and helps to adhere a mixture, which could include blood, millet flour, kola nuts, clay, plant gum, and bone. An additional surface treatment may include smoking with plant matter (Gagliardi 2010: 232). These surfaces are not removed, but subsequent layers or applications of blood are applied on top (Page 2009: 95; Brett-Smith 1997, 2001).

Figure 6: Image of the application of the surface (Jespers, P. 1995).

Komo headdresses emphasize what is seen and what remains unseen (Gagliardi 2010: 8). In this image, you may see an animal-like mask, with horns, quills and a brown colored surface. What is unseen to you is that the horns may contain secret packets and medicines to increase the object's power (Gagliardi 2010: 188). The cloth at the front may have been infused with potent plant materials (Figure 7). Everything seen and unseen about this mask is intended to communicate power and the danger of the unknown.

Figure 7: Image of X86.385 with arrows identifying the area of the horn filled with unknown materials and the cloth near the tip of the mask.

In many West African cultures, knowledge is not freely available to everybody, but instead its transmission is restricted based on a number of factors, including gender, age and membership. In the case of *komo* headdresses, only the maker and performers know its full secrets—such as the identity of its materials (McNaughton 1979: 29). Such secrecy defends the performer against sorcery. In contrast, Americans generally consider knowledge as free, and if they encounter something unknown, proceed to "Google" it.

As a non-member and a female, my access to and analysis of the masks and their materials is problematic within the context of *komo* associations that commonly restrict women's access to such objects. However, as a conservation student, I am interested in researching and identifying materials to develop better treatment guidelines for applied surfaces, in line with conservation principles.

4. Scientific Research of the Surface

Analytical study of the surface utilized five techniques: polarized light microscopy, X-ray diffraction, Fourier-transform infrared spectroscopy, X-ray fluorescence, and scanning electron microscopy. Analysis of the complex surface encrustation did not attempt to give a precise identity for each component, but instead focused on the following questions:

- Do the types of materials found in the surface of the masks correspond with reference materials based on the literature review?
- Do the samples show evidence of multiple applications of materials or a single application of a mixture?

- Can the ratio of organic and inorganic constituents be determined?
- Can the organic and inorganic materials be generally classified?

The answers to these questions may help to characterize the surface, but ignore the intangible elements of its manufacture (Blier et al. 2004; McNaughton 1979: 28-29; Gagliardi 2010: 171; Brett-Smith 1997).

The organic materials of the surface were investigated with three techniques. These techniques can identify general classes of materials, such as starches and proteins, and were not used to definitively identify all of the organic materials. This intentional vagueness helps to respect the secrecy of the surface while still researching the components.

As I discussed before, investigating the composition of the surface posses ethical issues. The surface components, particularly the plant materials, are "some of the most powerful and restricted media incorporated into [power objects]" (Gagliardi 2010: 158-59). After learning about the secrecy around the plant materials and discussions with *komo* scholars, I decided not to investigate the leaves or stems embedded in the surface.

4.1 Organic Materials: Polarized Light Microscopy

Samples of the object's surface were mounted as dispersions in Melt mount and examined with PLM to develop a basic understanding of the organic and inorganic materials present in the surface (Figure 8). The resinous matrix appears as a strongly amber colored composite material with conchoidal fractures that has a lower refractive index than the melt mount. It is isotropic, which is typical of an organic material. The black fragmentary material embedded in the matrix is probably charcoal, based on its color and the fact that it gives no response in polarized light. The shape is also very similar to the reference image on the right (McCrone et al. 1979).

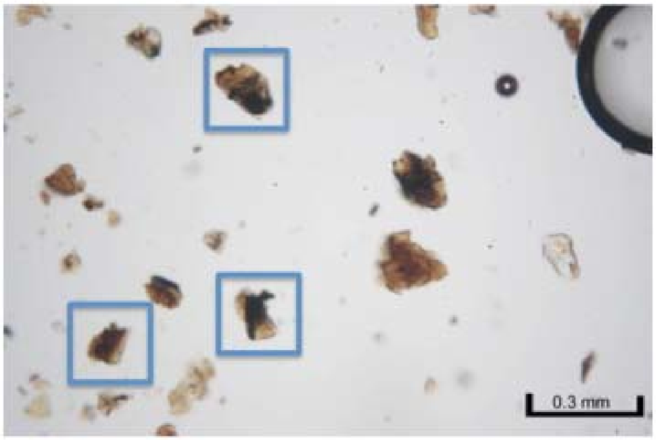

Figure 8: Left image is of a dispersion sample of X86.385 in Melt Mount (RI: 1.662). Right image is of wood charcoal, (McCrone et al. 1979 image 995, circularly polarized light).

4.1 Organic Materials: Chemical Spot Tests

Chemical spot tests were carried out on particles of the surface that had separated from the object as well as on the water-soluble components. For the most part, the results of the spot tests were inconclusive (Table 1). The samples may have had positive results for starches and proteins, however it was difficult to determine whether the positive blue/black and reddish colors had actually developed as a result of the chemical spot test.

Table 1: Several spot tests used on samples of the surface material

Test for	Spot test	Result
Starch	Iodine/ Potassium Iodide (Odegaard et al. 2005)	Possible Positive
Starch	Iodine/ Potassium Iodide *on water soluble components*	Negative
Protein	Ninhydrin (Nieuwenhuizen 1994)	Possible Positive
Blood	Kastle-Meyer (phenolphthalein indicator)[1] (Nieuwenhuizen 1994)	Positive

The blood spot test was performed with the Kastle-Meyer test, which uses phenolphthalein as the color indicator. The sensitivity of this test is such that it can detect

[1] The blood spot test was done with a *Phenolphthalein Blood Test Kit* (Item # 36 V 6134) from Ward's Natural Science (PO Box 92912 • Rochester, NY, 14692-9012; 800-962-2660)

blood present in a 1:10,000 dilution (Tobe et al. 2007). The hydrogen peroxide reacts with the heme group in blood to form water and a free oxygen radical. This radical then reacts with the phenolphthalein indicator, which turns pink. In the image below (Figure 9), you can see an image of the spot test results, with the positive control on the right and the sample on the left. The development of a pink color within one minute indicates a positive result.

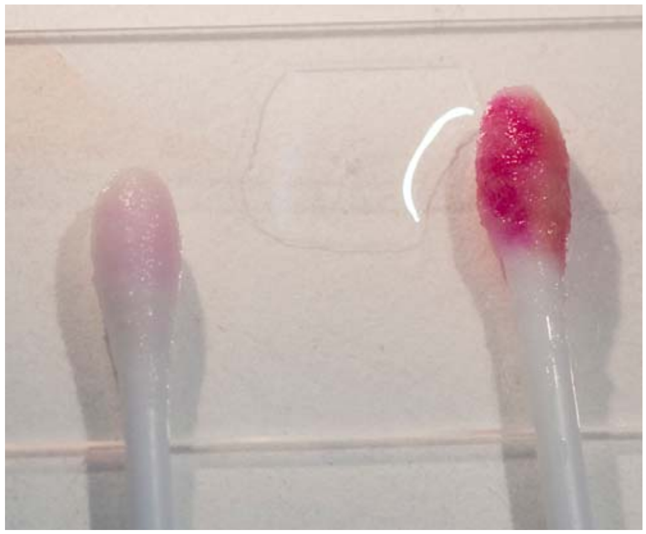

Figure 9: Positive results for Kastle-Meyer blood test. The positive control is animal blood. Color developed within 30 seconds.

4.3 Reference Materials: Kola Nuts

For reference, kola nuts from West Africa were acquired from two companies: Mountain Rose Herbs (Mountainroseherbs.com) and Bouncing Bear Botanicals (http://www.bouncingbearbotanicals.com). Whole grain millet flour was purchased from Bob's Red Mill. While this brand is probably not what is available in West Africa, it is likely to be similar enough for the analytical techniques. Since some references also discus the use of fermented millet flour, distilled water was added to a portion and it was left to ferment for several days.

Both Attenuated Total Reflectance FTIR and μ-FTIR were used to broadly characterize the organic reference materials and the organic materials in the surface encrustation. As you can see here (Figure 10), the kola nuts and millet flour spectra are very similar and both included carbohydrate peaks (1150, 1077 and 1014 cm^{-1}). Therefore, if any carbohydrates are present in the surface sample, it will not be possible to differentiate between millet and kola nuts based on FTIR.

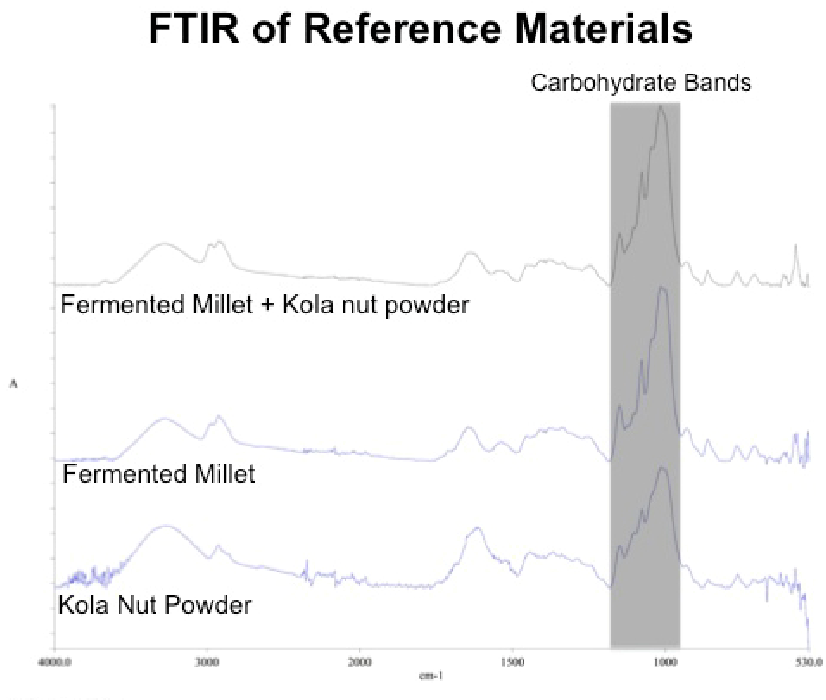

Figure 10: Graph of the FTIR data for the Millet and Kola Nut reference material. There is no way to consistently differentiate between the two materials using this technique. The analysis was done with a Perkin-Elmer Spectrum One infrared spectrometer in Attenuated Total Reflectance mode with a Zn-Se crystal.

4.4 Fourier-transform infrared spectroscopy of a Surface Sample

A small particle of the surface from the proper right side of the head area of the mask, was removed from the object and crushed on a diamond plate for analysis with the µ-FTIR. On this graph (Figure 11), the top red spectrum is the surface sample, the blood standard is in the middle and a quartz standard is at the bottom in dark blue. The blood spectrum has protein amide I and II bands (approximately 1600 cm^{-1}), which are visible but small in the data from the mask surface. There is also evidence for quartz, based on the characteristic doublet in the sample spectrum. The silicon-oxygen stretch bands dominate the sample data in the region where carbohydrates would be expected; however there may be some evidence for their presence.

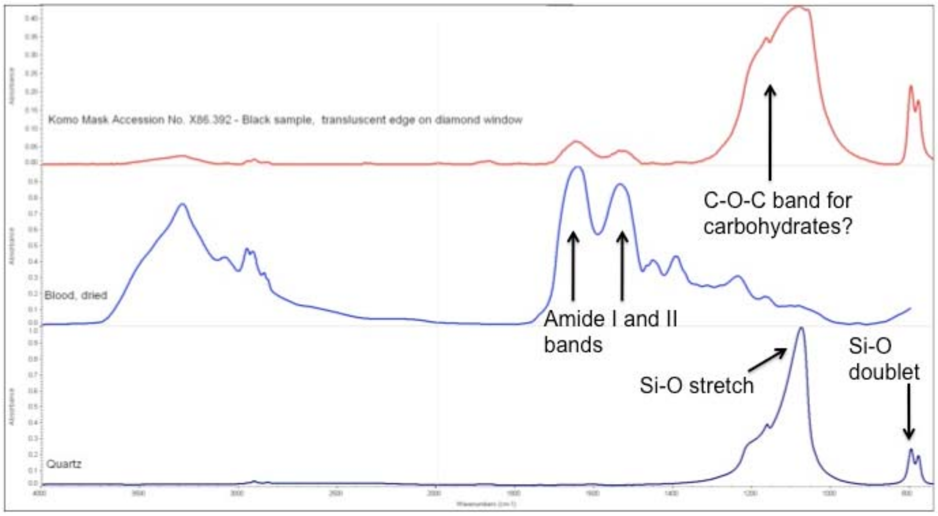

Figure 11: Graphs of the FTIR data for a surface sample (red) as well as a blood (light blue) and quartz (dark blue) standard. Analysis completed with a Hyperion 3000, ATR Diamond 80 micrometer facet.

For comparison, another area of the same sample was also analyzed. The top red spectrum is the data from this other area. The middle blue spectrum is blood and the lower green spectrum is a clay. Note larger amide I and II bands for proteins—probably from blood—in the top sample spectrum. The hydroxyl stretches in the clay spectrum are visible in the headdress' data as well. Once again, the silicon-oxygen stretch bands dominate in the region where carbohydrates would be expected. Depending on the particular area being analyzed, the sample spectrum consisted of proteins, clays, quartz and possibly a carbohydrate.

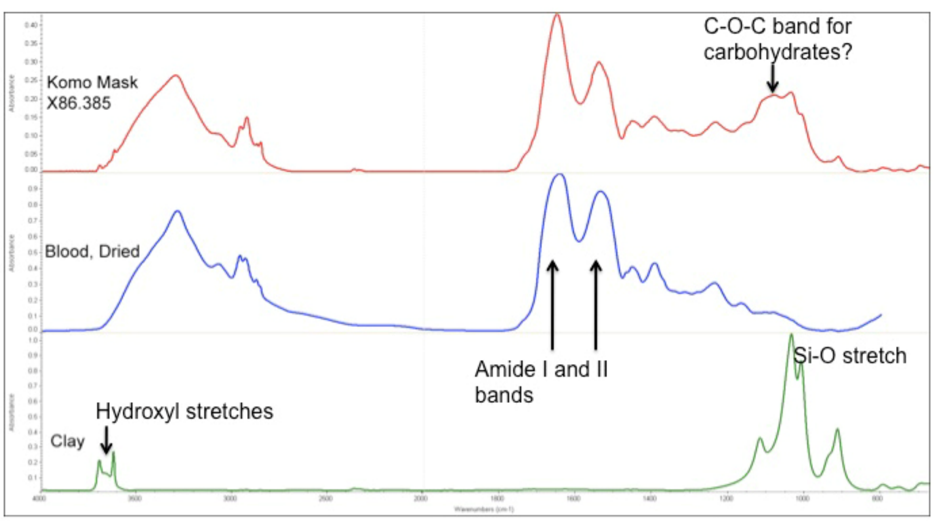

Figure 12: Graphs of the FTIR data for a different area of the same surface sample (red) as well as a blood (light blue) and a clay (green) standard. Analysis completed with a Hyperion 3000, ATR Diamond 80 micrometer facet.

4.5 Inorganic Materials: Scanning Electron Microscopy

The inorganic materials present in the mask are not elaborated on in the ethnographic literature but broadly described as clays. Several techniques (polarized light microscopy, X-ray fluorescence, X-ray diffraction, and variable pressure scanning electron microscopy) were used to investigate these inorganic materials. For this presentation, I will only be discussing the results of the variable pressure scanning electron microscopy both with a back-scattered detector and with energy dispersive x-ray spectroscopy.

For SEM analysis, two samples of the surface were removed. In this presentation, I will talk about the sample from the proper right side of the lower front mouth (Figure 13). The location of the sample was chosen to be both visually inconspicuous and representative of the surface as a whole. Below are images of the cross section of the sample before and after mounting. The sample was mounted in Bioplastic (Derrick et al. 1994) and then dry polished with micromesh.

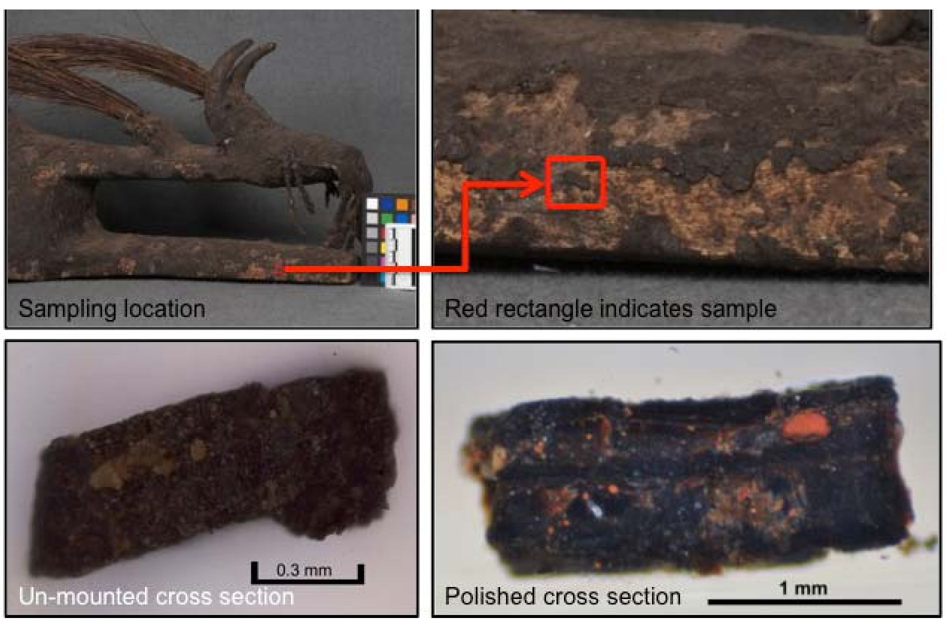

Figure 13: Above: images of the sampling location. Below: images of the sample form X86.385.

The images in Figure 14 reveals the complexity of the material. In the left image, taken with the SEM, I've outlined the sample area in orange. When looking at the SEM image, the grey tones are based on the mass of the elements, with the whiter areas corresponding with heavier elements.

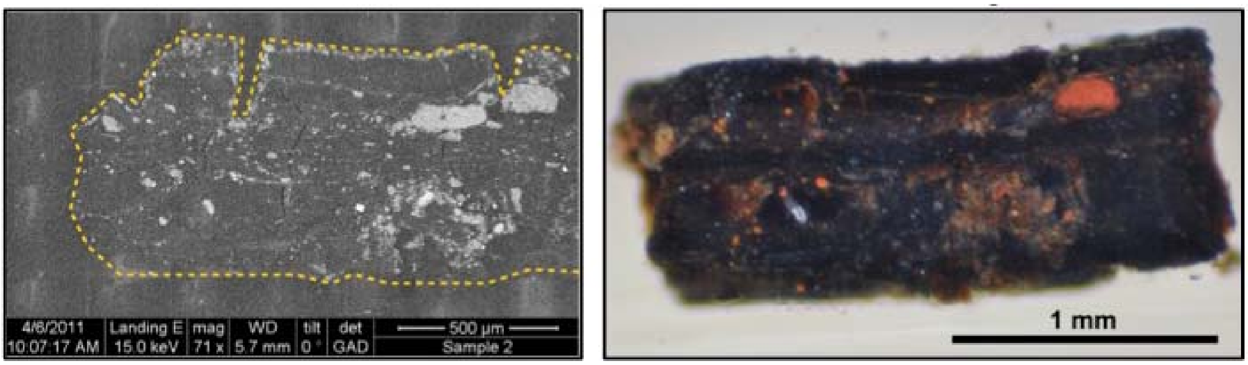

Figure 14: Left image is was taken with variable pressure scanning electron microscopy both with a back-scattered detector. The right image is a visible light photograph of the same sample.

A small area of the sample was selected for elemental mapping with EDX (Figure 15). The top most area, shown below in blue, is the Bioplastic in which the sample is mounted.

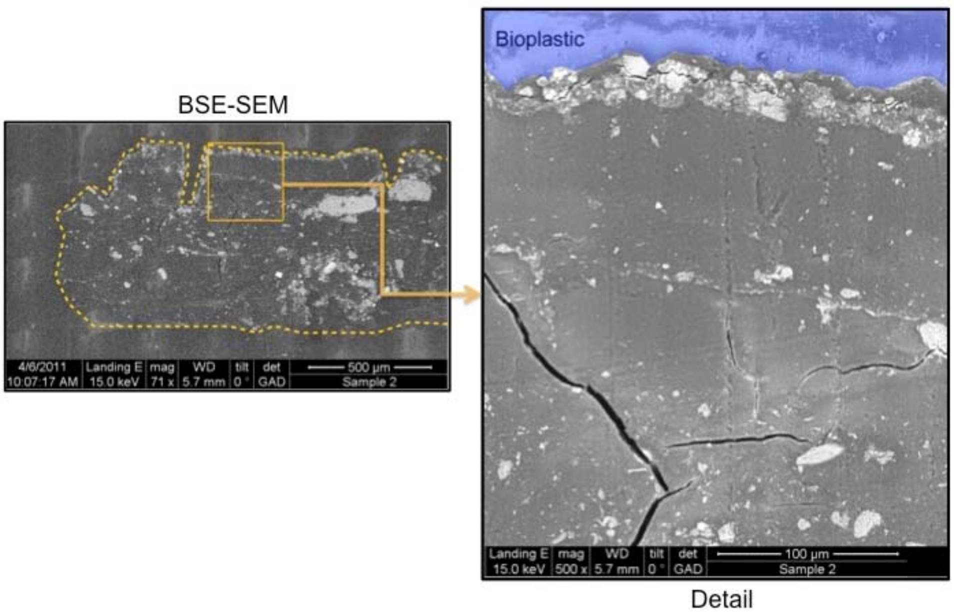

Figure 15: The left image shows the overall view of the sample, with the location of the detail marked with an orange rectangle. The right image is the detail with the mounting resin (Bioplastic) shown in blue.

Elemental mapping of the same detail area reveals that the matrix of material has a significant amount of carbon and is therefore probably mostly organic. Other elements also appear in the matrix material, but carbon is the most abundant. To interpret these elemental maps, colored areas indicate the presence of the element. Black areas indicate that the element is absent. Below are the elemental maps for oxygen silicon, and aluminum (Figure 16). There are many particles, particularly along the top or interior, where silicon and oxygen are both present, which suggests a silicate, possibly quartz. The elemental map of aluminum has many particles that overlap with silicon and oxygen, which may indicate an alumino-silicate clay.

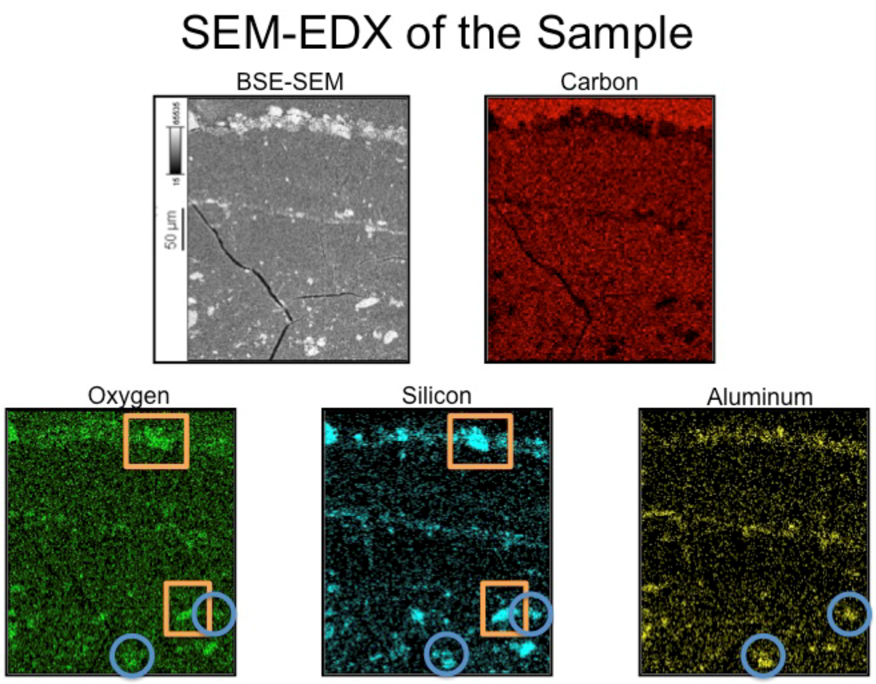

Figure 16: SEM-EDX maps for a detail of the sample from X86.385. The orange rectangles identify Silicate particles and the blue circles mark alumin0-silicate particles.

Both the top surface of the sample and an interior line are particularly rich in oxygen, silicon and aluminum and correspond with areas that are lacking in carbon. These regions may be due to intentional application or to deposition of dust or soil during storage or performance. Another study on the surfaces of neighboring West African Dogon statuary (Mazel 2006) also identified alumino-silicate clays between layers.

Based on the elemental maps, there seem to be several different possible layers within the sample (Figure 17). The surface layer is made up of mostly alumino-silicate particles, either from soiling or intentional application. It is interesting to note that this layer follows the edges of the crack that extends into layers two and three. Between layer 2 and 3 is another interface of quartz and alumino-silicate particles.

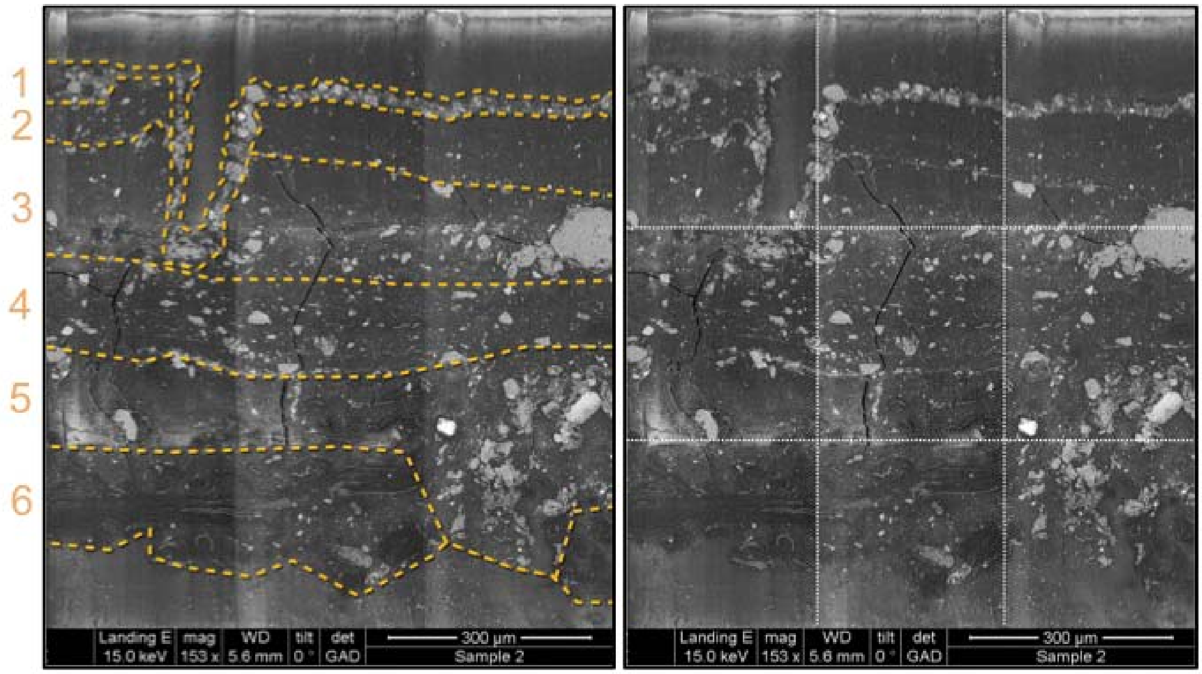

Figure 17: Image of a larger detail from the sample from X86.385. The orange dotted lines in the left image show the possible layers and the white dotted grid lines in the right image show the borders between the smaller images that were stitched together to form this larger image.

The boundary between layers 3 and 4 is less clearly defined and those layers have many large quartz grains as well as red iron rich particles. The lowest layer 5 includes what appear to be impressions of plant material, which would be consistent with applying a preparatory layer of plant gum. While the surface may appear to be a single layer with visual inspection, this analysis suggests a more complicated construction.

5. Conclusions

This investigation into the organic and inorganic components of the *komo* mask's surface has utilized many different techniques. The results indicate that the sample matrix is probably mostly an organic material with inorganic particles incorporated within and on top of the surface.

Based on the results so far, there is at least one carbohydrate material, such as kola nuts, millet flour or a plant gum. There is also some proteinaceous material in the sample, probably blood, but there may be a plant gum with a proteinacious component as well. Also present are charcoal or charred plant materials, which may be a result of the smoking of the headdress' surface. SEM analysis suggests the presence of a silicate, probably quartz, and alumino-silicate clays within the sample and also between layers. These results are in agreement with the findings of the other techniques.

When considering these results it is important to keep in mind that the materials and recipes involved in the creation of *komo* headdresses are probably not the same for each maker and each mask (McNaughton 1993: 133; Gagliardi 2010: 159). Additionally, headdresses made during different time periods could include different materials. However, these results can act as an initial guideline for understanding the applied surfaces.

Further research is still on the table for this project.[2] For example, it is hoped that the cross sections of the surface will also be mapped with FTIR to complement the SEM analysis. Additionally, the same analytical techniques have and will continue to be used to study the second *komo* headdress mentioned in the title of this presentation. Further research will also be conducted in the conservation literature to determine how to best preserve the mixture of blood, plant gums, flour and clays. In conclusion, the results of the analysis, which cannot provide any information on the intangible elements of the materials, agree with the materials listed in ethnographies.

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[2] For the final results, see Ohern, Robin. 2012. *On the Surface: A Cultural and Scientific Analysis of Two West African Komo Mask's Surfaces.* MA thesis, University of California, Los Angeles. ProQuest/UMI. (Publication No. AAT 1509680).

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