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On the Surface: A Cultural and Scientific Analysis of Two West African Komo Masks' Surfaces

Author
Ohern, Robin Rebecca

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On the Surface: A Cultural and Scientific Analysis of Two West African Komo Masks' Surfaces

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by

Robin Rebecca Ohern

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ABSTRACT OF THE THESIS

On the Surface: A Cultural and Scientific Analysis

of Two West African Komo Masks' Surfaces

by

Robin Rebecca Ohern

Master of Arts in Conservation of Archaeological and Ethnographic Materials

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Professor Ellen Pearlstein, Chair

Komo masks from West Africa are known for their complex and fragile surfaces accumulated over time as a consequence of ceremonial use. This examination begins with a review of the cultural context for the masks and a discussion of the ethics of performing research on these objects found in museum collections. Additionally, conservators at thirty museums with *komo* masks in their collections were surveyed to gather information on the history of *komo* mask treatments and current conservation approaches to these complex objects. The surfaces of two *komo* masks and reference materials are analyzed using polarized light microscopy, X-ray fluorescence, and X-ray diffraction. The results were then compared with the materials expected based on a literature review, including 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. The results are discussed in relation to the ethical issues of the research. The analysis identified the presence of blood, proteinaceous material, plant fibers, burned plant fibers, alumino-silicate clay, quartz, and red iron ochre particles.

The Thesis of Robin Rebecca Ohern is approved.

David A. Scott

Ioanna Kakoulli

Mary Nooter Roberts

Susan E. Gagliardi

Ellen Pearlstein, Committee Chair

University of California, Los Angeles

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To Adam Ohern

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Introduction

How should conservators treat the complex and accumulative surfaces of certain African objects? *Komo* masks, power objects that belong to *Komo* associations in the countries of Mali, Cote d'Ivoire, and Burkina Faso in West Africa are often characterized by an accumulated surface that can deteriorate and separate from the object support, altering the appearance and creating potential material instabilities. These masks present particular challenges for conservators responsible for their conservation. What materials make up the surface of the masks? What cultural or ethical issues should be considered in the handling and investigation of these objects? These questions have received limited analysis within museums so far. The conservation issues related to the surfaces of *komo* masks are not unique to this type of object. There are other masks and objects from Africa that have similarly complex applied surfaces, such as Dogon sculptures from present-day Mali and Kongo *minkisi* from present-day Democratic Republic of the Congo.. This paper will attempt to provide conservators with the answers to the questions about culture, ethics, and surface composition in order to guide conservation decision-making.

This research focuses on two *komo* masks at the Fowler Museum (Accession # X77.392 and X86.385, attributed to the Bamana peoples of Mali) that were examined visually and then selectively sampled and analyzed using polarized light microscopy (PLM), scanning electron microscopy (SEM) coupled with energy dispersive X-ray spectroscopy (EDS), , fourier transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD). Sample results were then compared with both published standards and results from analysis performed on reference materials chosen based on a review of the ethnographic literature. In addition, the cultural context of the masks, the ethics of analysis, and the conservation history of *komo* masks were investigated through ethnographic and scientific literature reviews and surveys.

Terminology

It is important to begin with a discussion of terminology used for the object type and its surface that are the focus of this thesis. The word "*komo*" itself can be written in a variety of different ways: *komo*, *kòmò,* or *kómó.* For this paper, I chose to use the unaccented, italicized and lower case "*komo*" for the objects, and uppercase "*Komo*" for the power association, This is consistent with the most recent publication by Colleyn (2009a), a scholar who has studied West Africa for decades .

The terms used to categorize *komo* masks—such as headdress, mask, helmet mask, and more—vary among their creators, owners and users in West Africa, among staff responsible for cataloging objects in museums, and among scholars who study the cultural context of the masks. While museums use the term, "mask" to describe the wooden object worn on the head of the performer, the term can also include the full-bodied costume as well as the performer. According to Jespers' (1995) field research, even just saying the name of the mask can be dangerous. To protect against that danger, the "language has no specific word that designates masks as a category. The masks have proper names but the members of the association [in which they are used] have developed euphemisms, which they use to talk about the masks safely" (Jespers 1995: 43).

While the words used to classify the *komo* masks by North American museums may not reflect the most up-to-date terminology, they are indicative of the general trends in classification and perception used by collection stewards. In order to learn more about the words used to describe and categorize *komo* headdress, a survey was conducted of *komo* masks in the western museums. If a museum described its mask as both a helmet mask and a Kòmò kun, then both terms were noted. By far the most common term used to describe the objects is "mask," used for 50% of the objects. "Helmet mask," a term used in art historical literature to describe a particular form of masks, was used to describe 26% of the objects, and headdress was used 12% of the time. This variation in terminology is interesting because the terms "helmet mask" and "headdress" have been defined by scholars to refer to different forms. The use of both terms reflects either the ambiguity of the masks or inconsistent use of the terms by scholars. *Komo kun*, a Bamana term for the objects that means "head of the komo", was used six times (18%), indicating perhaps that a small number of museums have researched the headdress' original contexts.

It is important to take into account that the labels given to objects in museum collections may not represent their actual use in their original culture. For example, *komo* headdresses are usually classified as having horns, quills and other attachments in comparison to *kono* masks from the regional *Kono* association, which museums present as having no attachments. This convention may be a result of a 1960s exhibition by Goldwater that began the association of *komo* masks with attachments and accumulations, and not representative of their use in Africa (Gagliardi 2010: 131-132).

The terms used by museum professionals reflect the terms used by scholars who have conducted field research on these power objects, though the latter group may use them with greater precision and more nuanced definitions. Jean-Paul Colleyn defends the use of the word "mask" arguing that it refers "not merely to the object—a headdress covering the face—but also to a figure [the wearer] embodying a metaphysical being" (Colleyn 2009a: 20). For him, the mask enables the development of an avatar of an unknowable entity (Colleyn 2009a: 20). Patrick

McNaughton also refers to the object as both *komokun*, headdress, and mask (McNaughton 1988: 129). Diamitani calls the objects "masks" and also uses the Senufo words for the objects: "warakun, 'head of wild animal,' and yirikun, 'head of piece of wood'" (Diamitani 2008). This article will refer to the objects as masks or headdresses, as the majority of museums and scholars do.

The ingredients of the applied surfaces of *komo* masks are frequently not listed in the materials sections of museum catalog entries. The most common terminology for the surfaces is "encrustation," used by 30% of the institutions. Nineteen percent describe the surfaces of their masks as consisting of mud or clay, often with a question mark next to the material. Fifteen percent of museums use some combination of the words "materials," "sacrificial," and "patina." Two descriptors used only by one institution each are "black accretion" and "mixed media." These terms are largely descriptive of the appearance of the material, do not reveal any of the secrets of the composition, and are not likely based on scientific analysis.

Scholars use a variety of different terms to discuss the applied surfaces on *komo* masks. These include "surface materials," "encrustation," and "skin" among others (Diamitani 2008; Imperato 2009b; Page 2009). Similar surfaces on other African objects have also been called "patina," a word borrowed from metal objects but with the positive associations of authenticity and age (Blier 2004; Mazel et al. 2008). Just as the *Komo* associations hide the headdresses, perhaps the use of general and visually descriptive terms is one way of obscuring the object from non-initiates by not providing detailed information. Even as more information becomes available about the objects, the continued use of the general terms can help to respect the secrecy of the headdresses. The terms also reflect differences in perceptions by museum professionals of the manufacturing of the surfaces: mixed media implies something applied intentionally all at once, whereas patina suggests something accumulated and altered over time (Pearlstein 2011). This thesis will refer to the surface as an applied or accumulated surface.

Cultural context

Powerful and dangerous *komo* masks are central objects of the *Komo* power association in West Africa. The *Komo* power association[2] is often attributed to the Bamana, or the larger Mande cultural group. However, other cultural groups in the area, such as the Senufo and other Gur-speaking peoples, also have *Komo* power associations (Diamitani 1999; Gagliardi 2010). Given the difficulty of creating solid boundaries between peoples, and because the *Komo* power association exists within many different groups, the cultural attribution is less important than the power association. This section will give an introduction to the masks through the Bamana context as represented in scholarly literature, given that most museums attribute these masks to the Bamana cultural group and that the two masks in the Fowler Museum have been attributed to this group.

Defining cultural groups in southwestern Mali as entities distinct from their neighbors is problematic and often does not reflect the complicated identities of communities. Attempts at such categorizations of peoples began with colonization and continue in many different forms today such as in museum exhibitions and object labels (Colleyn 2009a: 7; Gagliardi 2010: 19-20). Bamana[4] comes from the transliteration of a word used by the peoples' neighbors to describe them (Colleyn 2009a: 7). Currently it can describe people who speak the language of

[2] Also called "Initiation societies" (Zahan 1974) or "religious associations "(McNaughton 1979b).
[4] Bambara in French.

Bamana, or the Bamana ethnic group, sets that do not necessarily overlap in full (Colleyn 2009a: 7).

Most of the research on power associations has focused on groups within Mali, such as the Bamana (Gagliardi 2010: 4-5). Providing a cultural background for the Bamana will help to contextualize the *Komo* power associations that extend beyond the Bamana. The Bamana call their cosmology "*Bamanaya*," which, while it has some local variations, tends to consistently include the same essential features. Among these important characteristics are "the offering of blood sacrifices to ritual objects" (Imperato 2009b: 153). The world view of the Bamana is shaped by their environment and livelihood, which includes such agricultural activities as growing millet and corn as well as the management of herds of cattle, sheep and goats (Imperato 2009b: 153). The aspects that I will focus on include color, *nyama* (described below), and knowledge because of the relevance of these topics for an understanding of *komo* masks.

An important part of the Bamana cosmology that relates to the *komo* masks includes the development of color symbolisms. For the Bamana, there are three main colors: black, white and red. Black has a variety of different symbolic meanings associated with rain and black fertile soil, essential in an agricultural society. Black also connotes ideas of maturity, authority, power, knowledge, and obscurity (Imperato 2009b: 172; McNaughton 1979b). White also has a range of symbolic meanings including "harmony, joy, the ancestors, abundant food, union with God" (Imperato 2009b: 175). The third color, red, suggests "the center of the earth, the dry season… the ritual leaders and chiefs" (Imperato 2009b: 176). It is associated with war, hunting, killing, and *nyama*, the Bamana concept for "energy of action" (Camara and Bird 1974: vii-ix; Gagliardi 2010: 93) or "the energy that animates our universe" (Imperato 2009b: 176). As will be discussed below, each of these colors influences interpretations of the materials used on the masks. While conservation treatments try not to alter the color or aesthetics of an object, knowing that the colors of these masks are particularly important can help to guide conservation decisions.

Scholars describe *nyama* as playing an essential role in Bamana culture and *Komo* power associations (Colleyn 2009a; McNaughton 1979b). *Komo* power associations control *nyama* with objects such as masks in order to facilitate the success of the agriculture (Davis 1981: 4). *Nyama* can accumulate in people and things and it can transfer intentionally and unintentionally between different people and objects. Several aspects contribute to the accumulation of *nyama* in a given mask: the act of sculpting, initial applied materials, application of substances over its lifetime, oral recitations, and transfer of *nyama* from the wearer to the mask (Imperato 2009b: 151). Each part of the creation of a *komo* mask involves processes designed to invest the object with *nyama* (McNaughton 1979a). Once the mask is created, *nyama* can transfer from the wearer to the mask, and then back from the mask to a subsequent performer, thus connecting performances over generations (Imperato 2009b: 151). Therefore, the *nyama*, the power of the object and the thickness of the surface materials are directly related (Colleyn 2009b: 13; Imperato 2009b).

Gagliardi (2010, 95) found that leaders and elders in the communities she interviewed "most consistently explained that [*nyama*] is a potentially dangerous energy or force inhering to certain wild animals" and only occasionally mentioned it regarding power associations (Gagliardi 2010: 95-97). This does not mean, however, that *nyama* is not an important part of the way that people think about *komo* headdresses. Instead, Gagliardi found that people used the Senufo term "*fáríyá*" to describe performances and power objects. She differentiates between *fáríyá* and *nyama* with the help of her research assistant Ouattara Dahaba: "a power object used to cause harm is '*fáríyá*,' yet it is the '*nyama'* in the power object that caused the harm. Inherent in the notion of *fáríyá* is the ability to manage exceptional *nyama*, a force linked to any action" (Gagliardi 2010: 98).

In some cultures of West Africa, knowledge is not freely available to everybody, but is instead guarded and made known to only a subset of the community. People acquire knowledge from different teachers and can travel to a range of places in search of particular pieces of information (Gagliardi 2010, 178-179). Power association leaders "rely on knowledge and the interpersonal networks they build over time to assemble composite objects from diverse materials and to stage performances" (Gagliardi 2010: 67-68). In the case of the *komo* masks, only males who have been initiated into the society know the secrets of the masks. Even then, only the maker and performers of the mask know its full secrets—such as the identity of the materials that make up the mask and the process of making it (McNaughton 1979b: 29).

Specialized, secret knowledge is "only valuable if few people know [it]" (Imperato 2009b: 170). Although certain types of knowledge may remain a secret, the existence of the secret is public knowledge. As Mary Nooter [Roberts] (1993: 24) explains, "…one function of art in Africa, then, is to act as a visual means for broadcasting secrecy" while maintaining the secret. The secrecy of knowledge may be to guard the thing known, or to protect the uninitiated from danger. In the case of the masks, the secrecy of its manufacture and ingredients defends the performer against the actions of sorcery.[5]

The Komo Power Association

An understanding of the cultural context in which these object were made can help when investigating their accumulated surface or when determining treatment approaches. While the

[5] Sorcery, like witchcraft or shamanism is a term fraught with complications in the English language that do not exist in West African meanings. Here, I use the word sorcery as Gagliardi (2010, 109) defines it: "the calculated manipulation of the natural environment and metaphysical or otherworldly energies to achieve certain ends."

komo power association is often attributed to the Bamana, or the larger Mande cultural group, recent research suggests that the *komo* power association transcends cultural boundaries. It should therefore not be limited to just one particular group (Colleyn 2009a; Diamitani 1999; Diamitani 2008; Gagliardi 2010: 14; Jespers 1995). Instead, it may be more helpful to locate the *komo* power association loosely based on its geography and to understand it as its own phenomenon. *Komo* associations have responsibilities amongst their communities, control and employ *nyama*, and exert political influence.

Villages often have more than one power association: the *Komo* association is not necessarily the only group in the village. For example, it is one of six male power associations (dyo, pl. dyow)[6] among the Bamana, where it acts "as a village and even regional police force" (Imperato 2009b: 166; Zahan 1960, 1974). Power associations "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 the community where they operate (Colleyn 2009a: 25-26; McNaughton 1979b: 3). The *Komo* society can provide its services to both members and non-members (McNaughton 1979b: 2).

Two of the important aspects of these power associations is the guarding of esoteric knowledge (Imperato 2009b: 155) and protection against sorcery through the use of power gathered from the energy from nature (Colleyn 2009a: 35; McNaughton 1979b: 9-10; in Gagliardi 2010: 70, 72). As McNaughton (1993: 130-31) explains, "Kòmò's primary mission is to protect society from acts of natural and supernatural violence and to enhance the individual well-being and quality of life of every society member who petitions it." Within that primary

[6] Spelling based on Imperato 2009. Alternate spellings include: *jo*, pl. *jow* (Colleyn 2009a: 25).

goal, the *komo* masks "function as instruments of divination and destroyers of criminals and sorcerers" (McNaughton 1993: 129-30).

Countering sorcery is important both on a community level and on an individual level (Gagliardi 2010: 70). For example, sorcerers in the audience of a *komo* performance could attack the performer with poisons. Objects are essential for the association's ability to wield and gather power (McNaughton 1979b: 9-10; in Gagliardi 2010: 70). The *nyama* of the performer, combined with the potent symbols and ingredients on the mask, act as protection (McNaughton 1979b). 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 used, and the application of substances over its lifetime (Imperato 2009b: 151).

The blacksmiths, who are often but not always the leaders of the *Komo* power association (Gagliardi 2010: 130), have liminal roles in society, acting as healers, leaders of power associations, and creators of a wide range of objects, ranging from door locks to powerful masks (Imperato 2009b: 151). The blacksmiths assume these roles because of their access to large amounts of *nyama* and abilities to control and direct its flow. Their control over *nyama* and roles in the *Komo* power association make them very powerful individuals (Imperato 2009b: 169).

Komo associations are important politically because of their religious power and the networks they form from village to village. The associations create solidarity between different clans that is not kinship dependent (McNaughton 2001). The blacksmiths who lead *Komo* associations are very powerful members of the community. Blacksmiths cannot be political leaders of the village, and the political leader of the village cannot be a blacksmith (McNaughton 1993: 130).

Komo masks play an important role in the political influence of *Komo* power associations. While the practices may vary among different local associations, some village *Komo* power associations often have more than one *komo* mask, one of which is the mother mask, identified by its accumulation of *nyama*. The mother mask is not performed but remains in the shrine and receives applications of blood and other materials (Colleyn 2009a: 36). The other performed masks, however, can be given to the *Komo* chapters of other villages, "to forge inter-village political and religious connections and genealogical linkages" (Imperato 2009b: 180). Therefore, *komo* masks may not all receive the same type of ritual use, even if they came from the same association.

Members of *Komo* power associations have periodic meetings during which disputes would be settled, initiations completed, and solutions to problems determined by divination. The *komo* mask performance is important to all aspects of the meetings (McNaughton 2001). The object itself is only one component of the overall performance. Images of *komo* masks in use depict them worn on the head, with the dome section resting on the crown of the performer's head, like a baseball cap (Gagliardi 2010: 3). The mask is worn with a body-concealing costume, often of cloth with feathers attached (McNaughton 1979b: 31; Zahan 1974: plate XXIV.1). The performer would hold a "small whistle-like horn," which he would use to give voice to the mask (McNaughton 1979b: 37). This speech is then interpreted by the mask's herald, who accompanies the performer through the night (McNaughton 2001). The auditory aspects of the masks' performance are analyzed in detail by Jespers (1995).

Performed in the dark, the meaning of the ambiguous form of *komo* masks shifts and transforms without concrete definition. The general form can suggest both a mythical hyena or crocodile or the female vagina. The gender of the mask also shifts between male and female: the mother mask is a female but it possesses male attributes (Imperato 2009b: 180-1). Sarah Brett-Smith (1997) analyzed gender dynamics of *komo* masks and *komo* power associations.

When the masks are not in use, they are stored either in a secret location or in the house of the *Komo* association. In either case, the masks can be viewed only by the initiates and great care is taken so that nobody can look through the door and accidentally see one of the masks. The secrecy of the location of the object protects both the mask and the non-initiates: contact with women can eliminate power stored up in objects like the *komo* mask (Brett-Smith 1997) and the sight of the *komo* mask by an uninitiated person can result in death. Diamitani (2008) includes an image of two masks being placed into a large bag for transportation, but which may have also been used for storage. A similar concern with seeing and not seeing and with knowledge and secrecy occurs regarding the materials used to make the surface of the headdress.

The Komo *Masks: Materials and Meanings*

In conjunction with the discussion of the materials found on headdresses by scholars, this section will consider materials within the context of the masks in western museum collections. In order to do this, a survey of museums in the United States was conducted and images of their *komo* masks were acquired. The museums whose collections include *komo* masks are listed in Table 1. The images and catalogue descriptions were then studied to learn more about the horns, quills, and other materials attached to them. Visual comparison between the thirty-four masks in western collections, presented below, may help to inform conservation treatment decisions, for example, about the orientation of quill bundles. The focus of this section is the meanings and interpretations behind the materials on *komo* masks based on information scholars have collected from the field and identifications museums have made through various methods, not all of which may be scientific.

The blacksmiths or maker carves the masks out of wood and attaches grasses, quills, vulture feathers, nails, antelope horns, and cowry shells. The carving process involves finding a particular type of tree, the location of which identifies the place where the creation of the mask will occur. When a sculptor creates a mask, the community knows the location of the work and intentionally avoids it. The creation of a mask involves the transfer and deployment of large amounts of *nyama* that could be extremely dangerous for people who are not used to such "potent doses" (McNaughton 1993: 133). The colors and shapes of the horns, feathers, quills, grasses, bristles, and cowrie shells influence their use on the mask and strongly suggest power and intimidation to the viewer (Imperato 2009b; McNaughton 1979b).

While there are probably significant variations in processes of applying surface materials to *komo* masks, there are some aspects of construction that remain consistent in the scholarly sources (Brett-Smith 2001; Colleyn 2009a; Dieterien and Cissé 1972; Imperato 2009a; Jespers 1995; Lamp 2004; McNaughton 1979b). In respect of the restrictions of secrecy associated with certain materials, this study limits discussion to those materials that have already been included in published accounts and that are not considered to be a revelation of secret knowledge. 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 applied next, which could include blood, millet flour, kola nuts, clay, plant gum, and bone (Brett-Smith 2001; Colleyn 2009a; Dieterien and Cissé 1972; Imperato 2009a; Jespers 1995; Lamp 2004; McNaughton 1979b). An additional surface treatment may involve smoking the surface with plant matter (Gagliardi 2010: 232). These surfaces are not removed, but subsequent layers or applications of blood are applied on top (Brett-Smith 1997, 2001; Page 2009: 95).

Horns

Following the carving of the wood, the blacksmith may also have to hunt for the horns, tusks and quills to place on the mask and dig a well to acquire fresh water for use during the preparation of the surface (McNaughton 1993: 133). Horns suggest aggression, durability, power, and the bush by acting as synecdoches for the strength and durability of the antelopes. Horns often serve as containers for medicines and are thought of as poisonous arrows or darts (*binyew*). These two characteristics strongly connect horns with power and sorcery (McNaughton 1993: 136). Horns are a frequent component of *komo* masks, perhaps due to the connection between horns and *komo* headdresses established by the Goldwater exhibition described above, and McNaughton included them in his attempt to identify the elements of horizontal masks, including but not limited to *Kòmò* masks (McNaughton 1991).

While horns are an important characteristic of *komo* masks, they are not necessarily diagnostic. Of the thirty-four masks examined in western collections, 59% of them had two large rear horns present, 12% of the masks had wooden stubs with missing horns and 6% had many horns that were not arranged with two at the back. Only 9% did not have any evidence of rear horns. This variation within *komo* masks is in accordance with McNaughton's (1991) broader research that concluded that two rear horns are an important but not essential characteristic of horizontal masks.

Quills, Grasses, and Bristles xxx

The quills symbolize aggression and violence (Gagliardi 2010: 181-82) as *binyew* (poisonous arrows or darts) that protect the mask against sorcery (McNaughton 1993: 136). Porcupines, from whom the quills are gathered, "symbolize wisdom, the sage, one who knows much and is a protector of knowledge" (McNaughton 1993: 136).

As with the large rear horns, bundles of porcupine-like materials are a common, but not universal characteristic of *komo* masks. Even within masks that have such bundles, they can still vary in terms of material and form. Museum catalogue descriptions of the bundles describe them as composed of porcupine quills or, less frequently, grasses and hog bristles. With regards to form, the bundles occur as distinct individual bundles, as groupings of quills with a horn included in the bundle, or as a larger round cluster of bundles wrapped by cord, based on my observations of masks in museum collections.

Iron Nails

Visual observation of the two headdress in this study found that iron nails hammered into the wood serve as the armatures holding quill bundles upright. The nails can develop into a red color through the creation of rust and thus imply the existence of *nyama* within them as well as the *nyama* required to forge them (Imperato 2009b: 176). The iron nails used for *komo* masks can be forged from a local source or a recycled source, or the fully made nails can be imported from Europe. Differentiation among the various sources for the iron nails can be determined with scientific techniques that identify particularities of metal composition. Early African iron artifacts often contain a high nickel content, indicating the use of meteoric iron (Blakely 2006: 61). Locally smelted iron often contained charcoal and mineral impurities, which influenced the working and usage properties of the iron objects (McNaughton 1993: 31). Additionally, metallographic examination can also help to differentiate between western imported nails and indigenously produced ferrous materials.

Nyama connects iron nails, smiths, and the *Kòmò* masks. Smiths are people who possess large amounts of *nyama* and are capable of directing it. Activities such as "hunting, smelting or forging iron" require large amounts of *nyama* and are therefore best done by the smiths. The *nyama*-controlling blacksmiths are able to infuse *komo* masks with the force and the presence of the iron nails, adding to the potency of the object (McNaughton 1979a).

Museum catalogue descriptions for only 26% of the masks provided in the survey either mentioned metal as a material, or referred to a loss of quill bundles and exposed metal armatures. However, it is likely that nails are present in the other masks either to attach the horns to the object or to act as an armature for the quill bundles. The lack of the inclusion of metal as a material in the catalogue entries for the objects may be one indication of the lack of investigation these masks have received within museums, since the presence of the nails can often only be determined with either visual analysis or X-ray radiography.

Feathers and Birds

Vulture feathers symbolize knowledge and wisdom and are important to the meaning of the masks (Imperato 2009b: 174). The Bamana think of birds as being able to move between the sky and the earth, and thus act as mediators between people and spirits. Birds may also give people the knowledge of the spirits and assist in divination (McNaughton 1993: 137). In addition to adorning *komo* headdresses, bird feathers may also decorate the cloth costume of the mask wearer (McNaughton 1993: 136). The feathers may be attached to the object to increase the headdresses' divination abilities.

Visual analysis of images of headdress in museums found that ten of thirty-four masks (30%), an unexpectedly small number, still had examples of feathers either on the tips of the horns, in the quill bundles, or otherwise attached. Other masks may originally have had feathers as well, but the feathers may have been removed or lost over time. Feathers feature prominently in literature descriptions of the materials attached to *komo* masks, and their significance is important to construction and conception of *komo* masks.

Only a handful of the headdresses surveyed include bird skulls attached to their tops. These skulls are also often covered by the applied surface material. McNaughton notes the occasional presence of a bird skull on *komo* masks (McNaughton 1993: 143). The significance of the bird skulls is probably similar to that of the bird feathers. The variation in masks with and without bird skulls may support the idea that masks were created for specific purposes and contexts (McNaughton 1979).

<u>Other materials</u>

Cloth and cowry shells on the masks may be interpreted based on their color and their role within the culture at large. Cloth and cowry shells were both used as items that could be exchanged, similar to money. Their presence on the masks can therefore be understood in terms of a sacrifice of something particularly valuable (Page 2009: 94). Additionally, the wrapping of cloth among the Bamana "is a highly charged symbolic act" associated with menstruation and female circumcision (Brett-Smith 1983: 58). One of the most important characteristics of cloth is its ability to absorb substances, particularly blood and *nyama*. The ability of these cloths to both “absorb and then display blood” is significant for their power (Brett-Smith 2001: 120). Therefore, it may not be surprising to find cloth wrapped around an object that receives applications of blood, along with other materials. Following the carving of the wood and the addition of the horns, quills, nails, and cloth, surface materials are coated onto the object.

Finally, the survey of *komo* headdresses in museum collections found that some materials occurred on a small number of the objects. These materials are not discussed in the literature and include:

- Mirrors, found on three masks
- Animal hair, found on five masks
- Glass, found on one mask
- Bundles of unknown materials, found on five masks

These materials demonstrate the flexible decision making present in the process of acquiring materials and creating *komo* masks.

The Surface of the Mask: Materials and Meaning

The surface materials, based on recipes called *daliluw*, directly contribute to the headdresses’ *nyama*. *Daliluw* can refer to either powerful amulets or recipes for materials such as those applied to *komo* surfaces (McNaughton 1993: 131). Alternatively, Colleyn describes them as “a secret spiritual power, a protective medicine, the occult knowledge obtained from a qualified master at the end of a long quest. It is a specific protocol for assembling, activating and directing a set of energies to obtain a desired effect” (Colleyn 2009b: 57). In brief, the recipes published by scholars for the surface materials include building up a layer of crushed plant bark and root paste and applying a mixture of blood, chewed kola nuts, alcoholic beverages, millet (*dègè*) and other possible unknown materials (Imperato 2009b; McNaughton 1979b: 23, 34). Power association leaders emphasized "the importance of smoking a mask with specific plant matter" which made the "sight of the treated mask dangerous and even life-threatening to women" (Gagliardi 2010: 232). The plant materials used in the surfaces of these masks, such as "roots, stems, bark and leaves" are "some of the most powerful and restricted media incorporated into [power objects]" (Gagliardi 2010: 158-59).

The published work of six scholars who have done field work among the Bamana people and are experts on their culture were consulted about the materials that might be present on the masks (See Table 2). All six scholars mention blood as part of the surface materials, and many of them emphasize its repeated applications. All but Jespers (1995) discuss millet flour—either mixed with water or milk, or fermented—as present in the surface mixture. Three different sets of scholars note the presence of kola nuts, clay and plant gum in the surface. Finally, two scholars suggest the presence of bone, either powdered or fragmented, in the surface. The results of this literature review suggest that blood, millet flour, kola nuts, clay, plant gum, and bone may all be present in the encrustation (Brett-Smith 2001; Colleyn 2009a; Dieterien and Cissé 1972; Imperato 2009a; Jespers 1995; Lamp 2004; McNaughton 1979b).

The presence of human or animal excrement in the surface materials of the masks has been suggested but is uncertain in the literature. Imperato (2009b: 180) and Brett-Smith (1983) discuss the importance of excrement in the surfaces of *boli,* (another type of object with accumulated surfaces from the Bamana). When Imperato (2009b: 184) lists the ingredients in a *komo* coating, he leaves out excrement. At a later point in his article, however, he mentions that: "The outer shells of *boliw* as well as the surfaces of some *komo* masks sometimes contained dried human and animal excrement to which other sacrificial materials such as blood are added."

The use of excrement in the surface would augment the *nyama* of the mask, since excrement is considered to be particularly dangerous and full of *nyama* (Imperato 2009b: 169, 81; Zahan 1960: 168). McNaughton states that *komo* masks have the same applied surface materials as *boliw,* which includes excrement, but when he lists the materials in *komo* surfaces he does not mention excrement (McNaughton 1979b). The results from the two masks analyzed in this study were reviewed to determine whether they contain excrement in the discussion section below The creation of the surface of the object is a "crucial [process] in African art's 'social life' and an important part of what completes a sculpture" (McNaughton 2009: 2; Appadurai 1986). The importance of the surface of *komo* masks for the Bamana includes its indication of the accumulated *nyama* of the mask over generations (Imperato 2009b: 151). Therefore, the applied surfaces of sculptures were rarely intentionally removed by the original culture; subsequent layers were applied on the top (Page 2009: 95). The choice of materials in individual masks were influenced both by the cosmology of the Bamana and by their physical surroundings (Imperato 2009b: 152).

Reasons for use of each of the surface materials—kola nuts, millet flour, blood, clays, and plant gum—include sacrifice, *nyama*, and color symbolism. The kola nuts and millet flour may have been chosen because they could also be eaten by people: their use on a mask involved giving up something that sustained life (Page 2009: 93-94). The application of sacrificial animal blood to the surface transfers the animal's *nyama* to the mask. *Dègè,* fine white flour mixed by women with milk or water, suggests *nyama* through its visual similarity with breast milk and is considered to increase the power and provide strength to whoever ingests it (Imperato 2009b: 195).

It would be tenuous to assume that the materials documented from the 1970s field research accounts would continue to be used in masks made today. While the particular materials were chosen for specific reasons, it is possible that other materials available now could be integrated into the meaningful creation of surfaces (Gagliardi 2010: 159; Kahan 2009: 33). Another risky assumption is that the materials and recipes involved in the creation of the *komo* masks are the same for each blacksmith and each mask (Gagliardi 2010: 159; McNaughton 1993: 133). Additionally, Gagliardi (2010, 8) discusses the use of “difficult-to-obtain materials from distant locales.” However there do seem to be some similarities in the materials reported by scholars working in the 1970s as well as within the last five years.

The Masks from the Fowler Museum at UCLA

Both *komo* masks from the Fowler Museum at UCLA (X86. 385 and X77.392) have an underlying wooden form with the elements typical of these horizontal masks: a rounded head, an elongated mouth, and two large horns at the back (McNaughton 1991). The head area of the mask is a cavity so that it can be worn on the head of a performer. The wooden form has porcupine quills, feathers and animal horns attached to it by cords, plant fiber strips, cloth and metal nails. The surface of the object, including a large portion of the quills and horns, is covered with a dark brown encrustation. In both masks, this surface encrustation has a visible uniform distribution of large and small plant fibers. There are many areas of loss to the surface that reveal the wood beneath. Both objects were imaged with X-ray radiography to better understand the way they were made. The X-radiograph images confirmed that the objects are each made of one piece of wood and that the bundles and horns are attached with nails.

The larger of the two masks, X86.385 (68.5 cm x 21.7 cm x 24 cm) (Figure 1), has three sets of quill bundles arranged along the top of the headdress: two sets on the top of the mouth and one on the head area. The quills are oriented between 30-45° to the plane of the mask. The bundle near the tip of the mouth has two small horns on either side. There are also two larger animal horns attached to the upper backsides of the rounded head form. These two larger horns have the lower part of the calamus, or base of the shaft, from five to seven white feathers tied onto the object with white cord covered in the brown surface material. Two to three nails hold each horn to the object.

The surface of X86.385 is made up of a homogenous dark brown layer that is thicker on the top of the mask than on the sides. In areas of loss to the surface, there appears to be a slightly redder uneven material between the surface and the wood (Figure 2).

The smaller of the two masks, X77.392 (38.1 cm x 12.6 cm x16.5 cm), has eleven bundles of light and dark brown quills (bundles are approximately 1” diameter) attached by cords, plant fibers, and nails to the top of the object (Figure 3). The bundles are roughly arranged in a row down the center of the top of the mouth, and then in two rows on either side of the top of the head. Ten of the bundles are oriented at approximately 60° to the plane of the mask. The eleventh central bundle is now horizontal but may originally have been in the same orientation as the other bundles, based on the arrangement of the other bundles and observation of other masks. There are three locations on the top of the head that appear to be missing quill bundles.

The surface of X77.392 appears to have three layers of surface material: a layer of a smooth, dark, continuous, coherent brown material in contact with the wood, followed by a layer made up of plant fibers, and a top layer of a similar coherent dark brown material (Figure 4). These dark brown layers also contain long plant fibers.

The two masks have some similarities—both have two large rear horns and bundles of quills—but also some differences in their attachments. With regards to the surface, X86.385 has a thick layer of brown material with long plant fibers and red particles embedded in it and a craquelure pattern. X77.392 has a multi layer surface: above the wood is a layer of brown material, then a layer of plant fibers, followed by a layer of brown material. The different surfaces of the two masks were studied in detail to better understand their composition.

Scientific Background

There are no known published scientific studies of the surface of *komo* masks, however there are a few studies of similar surfaces from other types of objects. These studies include one by the scientists at the National Museum for African Art, Smithsonian Institution, on a figure from Ghana (No. 96-6-2) (Conservation Department n.d.), a study on the structure and components of *Boliw* with Computed Tomography scanning (Colleyn 2009b), an analysis of the patina on metal objects from Benin (Schrenk 1994), and several studies on the surface from neighboring West African Dogon statuary (Mazel et al. 2008; Mazel et al. 2006; Mazel and Richardin 2006; Pearlstein 1986; Richardin et al. 2006). The conservation literature includes one article (Nieuwenhuizen 1994) about chemical spot tests that can analyze accumulated surfaces.

Scientists at the Smithsonian Institution (Conservation Department n.d.) analyzed part of the applied surface on a wooden figure from the Akan peoples of Ghana (Accession number 96-6-2). They removed a sample from the clear yellow part of the black surface and analyzed it with FTIR. Their results indicated the presence of a proteinaceous material, a natural ester resin, and a polyvinyl acetate probably from previous conservation. They also used gas chromatography – mass spectrometry (GC-MS)to analyze pyridine soluble and hydrolyzed fractions but the data did not reveal the identity of the black surface colorant. They compared their research with a previous study that found sculptures covered with automobile paint or mixtures of carpenters glue and soot (Ross and Reichert 1983). In this earlier study, the surfaces of the authentic figurines were covered with brown and black pigments, black paint prepared from the *tatwia* root, and an unknown material (Ross and Reichert 1983).

Mazel et al (2006, 2008) analyzed mounted cross sections of surface materials from Dogon statuary using time-of-flight secondary ion mass spectrometry (TOF-SIMS), SEM-EDX, and FTIR. The authors were able to map out the locations of minerals, proteins, polysaccharides/starches, urate ions, and lipids (Mazel et al. 2006). The elements included silicon in quartz and clays, as well as calcium that corresponded to areas of carbonates as indicated by FTIR analysis suggesting the presence of calcium carbonate. The proteins were mapped through FTIR analysis by locating regions with the diagnostic amide II band at 1540 cm^{-1}. The polysaccharides were mapped through FTIR using the 1079 cm^{-1} band from the glycosidic linkage. The work of Mazel et al. on Dogon statuary is particularly relevant because the Dogon are located close to the Bamana in West Africa. Two articles have particularly helpful FTIR spectra and a discussion of the peaks (Mazel and Richardin 2006; Richardin et al. 2006).

A study by Pearlstein (1986) investigated the fatty blooms found on objects from the Bamana and the Dogon. Pearlstein analyzed samples of the white fatty bloom to determine their melting point and solubility and then investigated them with XRD, FTIR and GC-MS. The results found that fatty bloom represents a temperature dependent phase change in a fatty substance, which from some objects matched that of Shea butter, from other objects it was more similar to carnauba wax, and yet another object's fatty bloom matched palm oil. The ethnographic literature confirms that these materials were applied to the surfaces of the objects.

A search of the conservation literature found one article that addressed the issues of applied surfaces. Nieuwenhuizen's (1994) article on 'accretion depletion' includes a brief introduction about the difficulties of conserving applied surfaces. The bulk of the article guides the reader through spot tests that can help to identify surface materials. These spot tests include tests for protein, starch, blood, chloride, bromide, iodide, mercuric chloride, and arsenic. However, the current author found that the interpretation of the chemical spot tests is not always easy on complex mixtures such as these applied surfaces. For example, the spot test for starches requires that the viewer be able to determine if the sample has turned blue black, which is difficult if many of the particles are dark brown or black!

Ethical Questions

Several ethical questions relating to materials research of *komo* masks have arisen throughout this study. Navigation through these ethical issues was guided by the goal of this analysis: to provide conservators with information that may help with the preservation of these surfaces. This goal, however, had to be reached while respecting areas of cultural sensitivity regarding these objects. Some of the cultural ethical issues include the dynamic balance between knowledge and secrecy as well as between *nyama* and danger while investigating the object. Other important considerations include issues of gender, sorcery, art, and exclusivity.

Tension between knowledge and secrecy and between what can be seen and what is hidden enhance the power of the object as well as its performance (Gagliardi 2010: 186-87). In these instances, knowledge and the ability to see what is hidden , may give power to the maker, performer, or adversary. Some of the secrets of the mask are announced: bundles of restricted material are visible while their contents are not as are the holes in horns that indicate the presence of secret medicines without identifying them. Trying to transform the ambiguity between knowledge and secrecy into something concrete or specific—for example by identifying specific material components—ignores one of the important features of the masks (Gagliardi 2010: 188-90).

While the goal of the current investigation is knowledge, in the cultural context of the mask, knowledge is often found in conjunction with secrecy (Nooter 1993). Secrecy of information about the mask and its materials is important in its original context because "someone who knows all the materials and procedures necessary to build a powerful object also knows how to render the object ineffective" (Gagliardi 2010: 112). Once the secret is revealed, there is often a concern with transmission. In her research, Gagliardi (2010, 114) found that some people were suspicious of how she would use the information they gave her: would she use the knowledge to render them powerless, or "broadcast that knowledge on television and help augment the power of people in my home region." As a result of these concerns, even though the object is no longer in its original cultural context, I conducted the research with an awareness of how the information might be used once completed. Additionally, out of respect for the secrecy surrounding *komo* headdresses and geographic limitations, I relied on publications by and discussions with scholars who have conducted field research about *komo* masks for my sources of information, rather than attempting to interview someone from a *komo* society myself.

With regard to knowledge and research, to suggest that the entirety (i.e. scientific names as well as symbolic meanings) of the materials and methods of building up the surface can be discovered through scientific analysis presents a very narrow view of the manufacturing of the mask. The process of building up the surfaces may have also been accompanied by spoken words, smells, and touches (Blier et al. 2004; Gagliardi 2010: 171; McNaughton 1979b: 28-29). Additionally, the surface of a mask head preserves a record of interactions of many people over a long period of time (Page 2009: 40). Even if the components of the surface could be analyzed in full and the layers identified, the results would not provide a complete picture of the meanings and spiritual aspects of materials and methods of manufacturing.

One of the areas of particular ethical difficulty with this study was around the plant materials present in the surface of both masks. Both the identification of the plant materials and their harvesting methods are very restricted knowledge among makers of *komo* masks (Gagliardi

2010: 189). Some of the techniques used to investigate these masks can also provide information about the types of plant materials used but they are not able to give a precise identification of the plant species or provide any information on the way in which they were gathered.

In many ways the secrets of the mask—such as the composition of its surface material—remain restricted through the terminology used to describe it. For example, descriptions of the surface, as discussed above, typically use broad words such as encrustation, mixed media, or applied surface. Very few labels actually identify any materials (ex: clays or soils) and no labels actually list the many possible components. In some cases, however, the possible materials in the surface are mentioned in the descriptive paragraph accompanying the label.

Tensions between sacred or restricted objects and educational goals of many museums are not new for museums. Many museums' mission statements include some mention of education, or of increasing the public's knowledge regarding art. However, some museums that work with Native American materials restrict the viewing of scared objects in storage by placing them in opaque boxes. This type of storage solution may be appropriate for museums that wish to respect the cultural sensitivity of the *komo* headdresses. The open knowledge of western culture contrasts with the Bamana's guarded knowledge. For the Bamana, knowledge is restricted based on gender, age, and initiation.

In addition to restrictions regarding knowledge, there are also regulations about women and *komo* masks. Among the Bamana, women are not allowed to see *komo* masks and their contact with a mask may eliminate its accumulated *nyama*. While only permitting male conservators to work on *komo* masks may be the ideal situation, this is often not possible within conservation laboratories. Respecting the gender dynamics of a culture may be possible when doing field research, where female researchers can study associations of Bamana women, but within a museum exhibition or conservation laboratory, such divisions are more difficult to enforce.

Geographic and individual specificity is another way to consider ethical issues about researching komo masks. For example, is *nyama*, the activating force within *komo* masks, present in *komo* masks located in western museums? Since women can deactivate *komo* masks, and since there are no mechanisms to reinvest the headdresses with *nyama*, it seems likely that the objects in museum collections do not contain *nyama*. Mellor (1992) suggests that the masks are only active in their original culture and generalizes that Africans do not consider objects as independently alive and would not expect the object to maintain its power outside of the cultural context in which it was made. Such a broad generalization does not take into account the vast range of cultures and perspectives on the large continent of Africa.

This is similar in theory to a practice recorded by McNaughton (1979: 29) whereby the mask maker is typically the mask wearer because they are the only person who knows the contents of the mask and therefore the only one that can activate it. Even within the context of the *Komo* power association, the performance of the mask is person specific. Since we do not know the contents of the mask or how it was prepared, we cannot activate its power. Additionally, interacting with a mask head without know its material composition is very risky.

In conclusion, can an investigation into the surface of these masks be done both ethically and scientifically? The safest approach to these masks could be no analysis at all: this could be construed as being the best way to respect the culture of the masks. Alternatively, the masks could be approached from a fully scientific perspective, where their cultural issues are ignored and the ethics are absolved through objective rationality. In the case of these masks, however, I think that neither approach is suitable. The continued treatment of surfaces such as these without having a clear understanding of their composition or structure runs the risk of damaging them. However, conducting the analysis without a respect for the cultural context could result in revealing highly restricted knowledge unnecessarily. Instead, I propose a type of analysis that confirms material constituents previously reported, while also reporting on the material meanings in a way that inspires deeper understanding and respect for cultural context.

Conservation Approach: A Survey of Conservators

Given the importance of the surface encrustation as a record of the life history of the object and its connection to the *nyama* accumulated on the object, how should conservators stabilize and consolidate the surface? Conservation approaches from various museums to the treatment of *komo* patinas have included reattaching material with synthetic or natural resins, storing separated surface material in museum files, or discarding lost patina, with delamination considered an inherent deterioration process of the objects. In order to better understand the previous and current approaches to the stabilization of *komo* mask heads' surfaces, attitudes were assessed through targeted surveys of colleagues.

Thirty museum conservators, registrars and curators were contacted, about the conservation of forty masks or objects in museum collections. The tables at the end of the document contain a list of the museums contacted for the survey as well as the survey itself (Tables 1 and 3). Twenty-one of these museums had *komo* masks, nine of these museums had *kono* masks or *boliw*, which have similar surfaces. Twenty museums responded to the survey, yielding a response rate of 66%.

<u>History of previous treatment of masks</u>

Of the museums contacted, nine of the twenty-two masks (41%) included in the responses had conservation records. Aside from the two objects in my thesis, only one headdress had been analyzed with X-radiography. No additional analytical techniques were reported. Documented techniques and materials used to stabilize the applied surfaces in the past include gelatin, Klucel® (hydroxypropyl cellulose), Lascaux (acrylic emulsion with butyl acrylate and methyl methacrylate and acrylic butyl ester), methylcellulose, Paraloid® B-72 (an ethyl methacrylate and methyl acrylate copolymer), Paraloid® B-67 (isobutyl methacrylate polymer), and polyvinyl acetate resin. Paraloid® B-72 is the only material used on more than one object. The variety of consolidants used to treat the masks may suggest that the applied surface of each particular mask does not respond the same way as the others to a given consolidant. The fairly conventional and commonly used materials indicate that treatment approaches to the masks may be similar to those used for other types of objects in museum collections made of similar (and dissimilar) materials.

Loss compensation techniques used in the past for these surfaces include: Paraloid B-72 with glass micro-balloons, Paraloid B-72 (or Lascaux) and cellulose powder, Hollytex (non woven polyester fabric) toned with acrylic emulsion paints, and Japanese tissue paper bridges toned with gouache. These attempted to match the texture and tone of the surface while maintaining conservation principles of reversibility and minimal intervention.

Besides surface treatments, conservators responded that the headdresses in their institutions have received other interventions, including: removal of insect casings, reattachment of feathers, reinforcement of quill bundles, and stabilization of the wood structure. In general, the conservation treatment history of these objects mostly involves surface treatments along with some insect-related treatments.

Current conservation approaches to masks

When asked what information conservators would want before beginning treatment, survey respondents emphasized conversations with the curator about the cultural context and complete material characterization. Additional desired pieces of information are similar to what are typically used to inform treatment decisions: record of past treatments, future use of the mask, i.e. exhibition, loan, or technical study, comparison with other similar objects to assist with treatment decisions, original use of the object, and response of the object to solvent testing in order to gauge material interactions.

Most respondents would only conduct surface stabilization if absolutely necessary, for example, if parts of the surface are in danger of detaching. Considerations that conservators / survey respondents listed they would discuss when deciding whether to stabilize a surface include: reversibility and aging properties of the materials applied in treatment, cultural concerns and curatorial input.

Most respondents were very unwilling to conduct loss compensation. In this decision making process, as with surface stabilization, respondents emphasized the importance of basing decision on a dialogue with the curator and cultural representatives. Concerns with loss compensation included reversibility, aesthetics, and cultural appropriateness.

The survey of the conservation approaches to *komo* masks revealed a lack of scientific analysis of material compositions, 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.

Experimental

This section will cover the removal of samples from the two objects of study in the Fowler Museum's collection and preparation of reference materials for comparison. For information on all of the analytical techniques and instruments, see the Table 4.

Sampling from the objects

Two samples were removed from each of the masks. The samples of the surface from X86.385 include one from the proper right side of the head and one from the proper right side of the lower front mouth (Figure 5). Samples from the upper and lower applied surfaces of X77.392 were also removed. The samples were mounted in polyester Bio-Plastic® (polyester resin) (Derrick et al. 1994) and then dry polished with sandpaper and micromesh. The locations of the samples were chosen to be both visually inconspicuous and representative of the patina as a whole. A small sliver of wood was removed as part of the second cross section from the top of the mouth. The samples were photographed before mounting and then again as polished cross sections (Figures 6 and 7). The mounting technique and polishing process was chosen based on the literature review (Cotte et al. 2009; Cotte et al. 2007; Cotte et al. 2008; Derrick et al. 1994; Mazzeo et al. 2007).

Reference Materials

Reference materials analyzed as a part of this study include kola nuts and millet flour; see Table 5 for complete information about the sources for the reference samples. The kola nut samples were analyzed as is: there was no additional preparation done. The millet flour was analyzed as it came and after a fermentation and drying process. No blood reference samples were obtained. Instead, the IRUG database FTIR spectrum for blood (The Infrared and Raman Users Group 2000: IPR00003) was used as the blood FTIR reference.

Results and Discussion

The surface of the *komo* masks were analyzed using five analytical techniques: PLM XRD, FTIR, μ-FTIR, XRF, BS-SEM and SEM-EDX. Analysis of complex surface encrustation did not attempt to identify precisely each component due to ethical considerations addressed in the preceding section, but instead analysis focused on answering the following questions:

- Can approximate ratio of organic and inorganic constituents be determined with PLM images, BS-SEM images or FTIR mapping?
- Can identities of organic components be narrowed down to classes of materials (i.e. proteins, carbohydrates, etc)?
- Can identities of inorganic components be narrowed down to classes of materials (i.e. clays)?
- Do resulting materials correspond with expected materials?
- Do samples show evidence of multiple applications of materials or a single application of a mixture?

As discussed above, the answers to these questions may help to characterize the surface, but ignore the intangible elements of its manufacture (Blier et al. 2004; Brett-Smith 1997; Gagliardi 2010: 171; McNaughton 1979b: 28-29). The results and discussion for each mask will be presented below, organized by the class of material identified.

X86.385

This mask was previously described as the larger of the two included in this study, with what visually appeared to be a single layer of applied surface on the wood. Plant fibers were visible embedded in the surface, as were red particles. This surface appeared fairly uniform throughout and the samples were taken from the proper right side of the head and the proper right of the mouth.

Matrix

The term "matrix" is used to describe the material that binds the other components of the surface together. Polarized light microscopy, scanning electron microscopy and FTIR revealed information about the matrix of material that holds the additional particles present in the surface. Samples of the object's surface were mounted as dispersions in Melt mount (RI 1.662) and examined with PLM to develop a basic understanding of the organic and inorganic materials present in the surface. When viewed as a dispersion (Figures 8 and 9), the matrix was resinous-like, with black and transparent particles trapped within it. The resinous-like matrix appeared 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.

SEM-EDX elemental mapping of a detail of a cross section, revealed that the matrix of material has a significant amount of carbon and is therefore probably mostly organic. Other elements also appeared in the matrix material, but carbon was the most abundant. Transmission FTIR analysis on small particles from the surface of the mask (Figure 10) indicate that the matrix has a proteinaceous component as well as possibly a carbohydrate (Table 8).

Blood and Proteinaceous materials

The presence of proteins was investigated with chemical spot tests and FTIR. One spot test specific to blood was also conducted (see Appendices 6 and 7 for spot test information). The sample from the mask may have produced a positive result for proteins, however it was difficult to determine whether the reddish colors indicated a positive spot test result, or whether these were due to saturation of the material. The protein amide I band (1650 cm^{-1}), amide II band (approximately 1540 cm^{-1}) and N-H stretching (3400 cm^{-1}) are clearly visible in the transmission spectrum in a small sample.

A 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 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.

The result of the Kastle-Meyer test strongly indicated the presence of blood in the sample. There are some other materials that will result in a false positive. These include potatoes, tomato sauce, red onions, cupric sulfate, ferric sulfate and nickel chloride and these materials tend to turn pink a minute or two after the application of the hydrogen peroxide or before all the ingredients have been added. In the case of the spot test on the mask, the pink color developed in less than a minute and only after all the ingredients were added (Tobe et al. 2007). This strongly suggests that the pink color did develop due to the presence of blood.

Plant material

As discussed before, investigation of the composition of the surface has 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 following discussions with *komo* scholars and a review of opinions in the published literature (Diamitani 2008; Gagliardi 2010; Imperato 2009b;

McNaughton 1979b), I decided not to identify the type of leaves or fibers embedded in the surface but instead to note their presence. Additionally, knowing that plant materials are present is more important for treatment considerations than having the name of the plant material.

The presence of plant materials was also investigated through PLM, chemical spot tests, FTIR and SEM. Polarized light microscopy of the dispersion samples did not reveal any plant material. Chemical spot tests may have given a positive result for the presence of starches, often found in plant material, but it was difficult to determine whether the blue/black colors that would indicate a positive result had actually developed as a result of the chemical spot test or were due to saturation of the material by the liquids added as part of the test. FTIR could not conclusively identify the presence of a carbohydrate such as millet flour due to overlap with a large quartz band in the main diagnostic region. Backscattered SEM imaging did not find plant materials present within either surface cross section for this mask. One of the cross sections, however, did have material that looked visually similar to plant fibers at the lowest layer of the cross section.

Kola Nuts

The XRF results for the kola nut reference materials suggest that the kola nuts do contribute to many of the elements found in the surface such as sulfur (S), potassium (K), calcium (Ca), titanium (Ti), manganese (Mn), iron (Fe) and strontium (Sr). The three kola nut references—the powder, the granules and the chunks—were analyzed with the same collection conditions as the mask surfaces. In general, all three kola nut references had similar spectra (Table 9). The kola nuts contribute to the elements identified on the *komo* mask surfaces but are probably not the only contributors to those elements.

FTIR was also used to attempt to identify kola nuts in the samples of the mask's surface. This technique was also not able to identify conclusively the presence of kola nuts in the applied surface. The main band for kola nuts as well as millet flour discussed below occurs around 1076 cm^{-1}, at the same location as the large band for quartz. While it was not possible to differentiate the quartz peak from the carbohydrates' peaks, it is possible that kola nuts and millet flour are both present in the surface based on the ethnographic literature.

Charcoal

Charcoal or burned plant materials were visible in the dispersion samples viewed with PLM. The black charred-looking fragmentary material embedded in the matrix is probably charcoal, based on its color and that it appears isotropic under cross polarized light. The habit is also very similar to a reference image (McCrone et al. 1979: Image 995). Additional techniques were not able to further confirm the presence of charcoal or charred plant materials. Charcoal does not have a distinctive FTIR spectrum (Guo and Bustin 1998; Nishimiya et al. 1998) and therefore did not appear in the data from the surface sample. However, the PLM data strongly indicates the presence of charcoal.

Clay and silicates

The presence of silica containing compounds was confirmed by PLM, FTIR, XRD, and SEM-EDS. When viewed with PLM, the clear crystalline particles occur both as morphologically distinct and separate particles, and as particles embedded in the resinous mixture. Some of the particles are probably quartz based on their lack of color and translucency, rectangular shape, and pleochroism from colorless to blue.

Other clear particles are isotropic and may be plant phytoliths, accumulations of amorphous silicon dioxide within plant cells that take the shape of cell structure. The shapes of the phytoliths appear to be oval, long thin shafts, and triangular shapes (Piperno and Pearsall 1998). The phytoliths may be present because of the inclusion of clay or soil—which themselves can contain phytoliths--in the surface encrustation as discussed below, or because of the burned and unburned plant material, or just due to contamination from soil or dust during the making of the surface.

Regarding the results from more quantitative analytical techniques, the bands typical of quartz (approximately 1100 cm^{-1} and doublet around 800 cm^{-1}) were visible in several FTIR spectra of the surface. The X-ray diffraction results for the surface samples strongly indicated the presence of quartz in the surface material. Since phytoliths are non-crystalline, they cannot be detected with XRD. Quartz was however detectable using FTIR based on the presence of its characteristic doublet at 798 and 780 cm^{-1}.

Finally, spot analysis with SEM-EDX on the particles visible in the cross section identified many of them as mostly silicon and oxygen. Some of the particles had similar amounts oxygen (O), silicon (Si) and aluminum (Al) with trace elements of nitrogen (N), iron (Fe), manganese (Mn), potassium (K) and phosphorous (P). Piperno (1988: 45) stated that phytoliths can have large amounts aluminum (Al) ,), iron (Fe), titanium (Ti), manganese (Mn), phosphorous (P), copper (Cu), nitrogen (N), and carbon (C) as impurities. These particles had very large peaks for aluminum, which may suggest that they are clay particles rather than phytoliths.

FTIR, XRD, XRF, and SEM-EDX suggest the presence of clays in the samples. FTIR Identified absorption bands characteristic of clays (elongation of the O-H at 3700 cm^{-1} and 3622

cm^{-1}, Si-O stretching around 1008 $cm^{-1}$and deformation of the Al-Al-O-H band at 915 cm^{-1}) when analyzing particles of the surface in transmission. Many of the elements found with the XRF were related to soils and clays (silica, calcium, titanium, manganese, iron, nickel) and the mask surfaces were found to have a relatively large amount of iron, even when areas with visible and concealed nails were avoided. The iron could derive from either the soil / clay in the surface, the kola nuts, or the frequent applications of blood to the surface during its cultural use. The X-ray diffraction results provided inconclusive results for inorganic materials besides quartz. Although no material corresponded well with the remaining peaks, the materials that came closest were all clays. SEM-EDX point analysis of particles in the cross section found that some particles had aluminum, silicon and oxygen, which may make up clay particles (Figure 11).

FTIR analysis also found some indication for the presence of clay in the sample. Both kaolinite and chrysotile seem to be present in the samples of the mask. Chrysotile ($Mg_3(Si_2O_5)(OH_4)$), also known as asbestos, is a silicate. This could indicate that the silicates found on the top most layer of the cross sections in SEM-EDX were asbestos that might have accumulated during museum storage. Kaolinite ($Al_2Si_2O_5(OH)_4$) is a white clay material that could be present in the soil.

Other studies on applied surfaces of Dogon statuary also found clays in the surface (Mazel et al. 2008; Mazel et al. 2006). Mazel (2006) notes that quartz and clays are present as two distinct phases with different spatial distributions. In Mazel (2008), the authors identified clays between layers and concluded that they came from environmental pollution and indicated a long duration of time between layer applications. Since identifying the specific phases of clays by X-ray diffraction was outside the goals of this project, their identification was not pursued further in this study.

Red particles

Visual observation of the surface of the mask as well as of samples of the surface found that they contain rounded red particles. Images of the cross sections in reflected light include these particles, which were best analyzed with SEM-EDX (Figure 12). These analyses found the presence of oxygen (O), aluminum (Al), silicon (Si), and iron (Fe) along with trace amounts of sodium (Na), magnesium (Mg), phosphorous (P), sulfur (S), chlorine (Cl), and potassium (K). This suggests that it may be an iron oxide particle with the additional elements being associated with the iron oxide particle or a separate matrix. The particles could be either added intentionally or as a part of another component, such as the clay.

Some materials not present:

Some of the materials that were tested for but were not present in the mask's surface include salts, organic pesticides, and excrement. Chemical spot tests carried out on surface particles that had separated from the object tested negative for the presence of chlorides and sulfates. Additionally, none of the inorganic pesticides typically found on ethnographic objects (mercury, arsenic, or lead) were present in the XRF analysis. This does not mean that organic pesticides—which would not show up using XRF—were not used.

The SEM-EDX point analysis and FTIR data were also examined for evidence of excrement in the surface material. A literature review suggests that excrement has a high concentration of nitrogen and phosphorus (Cambra-López et al. 2011; Shillito, Almond, Wicks et al. 2009). A review of the SEM-EDX data does not find a corresponding high concentration of nitrogen or phosphorus in the binding matrix. FTIR analysis of coprolites (fossilized dung) typically includes strong bands from calcite, phosphate, and quartz. The peaks for phosphorus typically occur around 1030 cm^{-1} (stretching) and 600/560 cm^{-1} (bending) (Shillito, Almond, Wicks et al. 2009). The area around 1030 cm^{-1} in the FTIR data is rather crowded and complicated and the spectra could only be recorded down to 598 cm^{-1}. However, if the phosphate doublets were present, they should be detectable at the edge of the spectra but they are not visible there.

There was one indication that fecal matter might possibly be present: the possible inclusion of spherulites. If fecal matter were present in the mask, then PLM analysis of the dispersion samples could have included calcareous spherulites, which are crystalline calcium carbonate with an organic coating (Canti 1997; Shillito, Almond, Nicholson et al. 2009). These may look visually similar to the particles embedded in the matrix that were previously identified as silicates (Matthews 2010). However they should have appeared in the XRD analysis or in the SEM-EDX analysis and their absence in the data suggests they are not present.

There are several challenges with the identification of fecal matter including its similarity to yellow ochre's and clays as well as the possibility that organic material in the surface which provides similar analytical results may actually be decayed food traces (Shillito et al. 2011). In the future, GC-MS could be used to determine whether excrement was used in the applied surfaces of these masks by looking for sterol biomarkers (Shillito et al. 2011).

Manufacture:

Questions regarding manufacture of the surface focused on whether the encrustation was applied as a single mixture or whether there were layers of applications visible. In order to address these questions, the surface was examined on the object and cross sections of the surface were analyzed with reflected light microscopy, SEM (using the GAD backscattered-electron detector), and FTIR.

The samples were photographed with reflected light (Figure 6). Reflected light microscopy can help to see the cross section's stratigraphy, but it is very difficult to differentiate any material or layers in these samples due to the lack of color differentiation and opacity of the material. In painting cross sections, layers are visible because of color differentiation or changes in the size of the particles visible.

With these cross sections, the color was uniform throughout and differentiating particles within the surface was difficult. However, visual observation of the polished cross sections for X86.385 did reveal that there may be a layered structure to the surface. In Figure 6 the quartz particles are only present in the middle of the sample and not present in the top or lowest areas of the sample. The samples also appear to have a thin-layered structure with inorganic materials marking the boundaries between the layers.

The backscattered electron image (Figure 13) of one sample was interpreted with help from SEM-EDX images to develop a proposed stratigraphy (Figure 14). 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. These regions of inorganic aluminum silicate particles between mostly organic layers 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 clays between layers. Between layer 2 and 3 is another interface of quartz and alumino-silicate particles. 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.

The SEM images also captured a large number of cracks in the cross section. The cracks occur perpendicular to the surface, probably due to the shrinkage of the matrix material. A detail (Figure 15) of the surface shows many smaller shrinkage cracks occurring in all directions, particularly around the dense white grains. This may indicate that the organic material was applied quite wet and that as it dried it shrank significantly. The prevalence of cracks in the surface may help to explain its structural instability on the object.

FTIR spot analysis of mounted Samples 1 and 2 confirmed the presence of proteins, clays, silicates and a long chain hydrocarbon, possibly oil. Five to nine different spots, beginning with the exterior upper most section and moving down the cross section to the lower, innermost section on each cross section were analyzed. This type of analysis can help to understand the distribution of materials throughout the cross section sample. Sample 1 had proteins present throughout the entire exposed sample surface, as did sample 2, with the exception of the calcite and silicate layer exterior upper most layer. The presence of proteins throughout the sample may possibly be due to contamination during polishing of the sample. Both samples have a long chain hydrocarbon, possibly a type of oil, present in the layers that were not contaminated with the embedding medium. This may suggest that the embedding medium solubilized and removed the long chain hydrocarbon. If so, then solvents should be used with caution on the mask due to their ability to solubilize and alter the materials in the surface. The long chain hydrocarbon is also present in the unembedded samples examined with FTIR. Clay seemed to be present mostly in the upper portion of Sample 1 and 2 and there did not seem to be a pattern behind the presence of silica containing materials. The FTIR and SEM-EDS results both indicate a mixture of materials, some of which are present throughout the sample (such as proteins), some of which are scattered particulates (such as the silica containing materials), and some of which may be more layered, (such as the clay).

X77.392

This mask was previously described as the smaller of the two included in this study. Visual observation of the surface of X77.392 indicates that it has several different layers. There is a layer of plant material closest to the wooden substrate followed by a layer of brown encrustation. On top of that another layer of plant material occurs and a final top layer of brown encrustation. Since the plant material layers were visible and their identification was not necessary for conservation purposes, they were not investigated further out of respect for the ethical issues discussed above.

Matrix

The matrix of X77.392 was investigated with PLM and FTIR. The matrix of this mask was very similar to that of previously discussed mask. The dispersion sample revealed an amber-colored resinous-like material with clear crystalline particles embedded in it as well as fragments of burned plant material (Figure 8). SEM-EDX was not conducted on this mask due to lack of instrument availability.

Blood and Proteinaceous materials

The presence of blood on the mask was also investigated. The ninhydrin test for proteins can detect the presence of blood, since blood is a proteinaceous material, but can give false positives if another protein is present (Nieuwenhuizen 1994). As discussed above, the phenolphthalein test for blood can also give false positives (Tobe et al. 2007). Blood specifically and proteinaceous materials in general were investigated with chemical spot tests for proteins and blood as well as evaluated using FTIR. Chemical spot tests on a sample from the mask may have had a positive result for proteins, but it was difficult to determine whether the reddish colors had actually developed as a result of the chemical spot test or were due to saturation of the material. FTIR confirmed the presence of a proteinaceous material, likely blood, due to the Amide I and II peaks in the spectra of the surface samples.

The blood spot tests were conducted on a sample from both the upper and lower surfaces. At the time of the spot tests, there were no fragments of the surface that had already separated from the object. Therefore, two small samples were taken for the test. This aids in the interpretation of the results, including about the location of blood on the mask, as the sampling sites are known. As with the other mask, the blood spot test was performed with the Kastle-Meyer test. The sample from the lower layer of brown encrustation, taken near the front of the mask, tested positive for the presence of blood. The sample for the upper layer, taken from the top of the head area, tested negative. This result may either suggest that the lower layer received applications of blood and the upper layer did not, or that the blood was primarily applied to the front of the mouth of the object and not to the head area.

Plant material

Inclusion of plant material within the brown encrustation was investigated with PLM, chemical spot tests, FTIR and SEM. Plant fibers were visible in the dispersion samples for this headdress. A sample that had already separated from the mask was tested for the presence of starches. However it was difficult to determine whether the blue/black colors had actually developed as a result of the chemical spot test or were due to saturation of the material.

The two cross section samples from X77.392 were imaged using back-scattered SEM (Figure 16). The results of this technique indicated some difference from the samples of the other mask (X86.385) that revealed large inorganic particles and possible layers. The upper cross section included two large plant fiber pieces with cellular structures visible along the edges of the sample but contained mostly rounded inorganic particles within the sample. The sample from the lower surface has almost none of the rounded inorganic particles within it but instead appears mostly composed of a network of plant material. Cross sections and longitudinal sections of complete and partial fibers as well as areas with possible parenchyma (plant tissue) cellular structures are visible (Figure 17). Parenchyma cells are found in many plants and have thin walls, a large space in their center, and irregular or polygonal shapes. The plant fibers may compose more of the visible cross section than the organic matrix material.

The identity of the plant fibers present in the mask is restricted knowledge within the *komo* power association. The information visible in the back scattered SEM image could help an expert in plant systematics or morphology to learn more about the plants present in the surface but would not enable them to identify the exact plants used. For conservation purposes, the identity of the plant material is not as important as its presence in the surface material. Therefore, I did not do any further identification of the plant material visible in the image.

Kola Nuts

The presence of kola nuts in the surface was investigated with XRF and FTIR. As discussed above with X86.385, their presence could not be conclusively identified, due to the similarity of their FTIR spectrum to that of millet flour. Additionally, many of the elements present in kola nuts through the XRF analysis could also come from other materials. Therefore, while their presence is likely, it could not be definitively determined.

Charcoal

As with the other mask, charcoal or burned plant materials were visible in dispersions of surface encrustation samples. The charcoal was both embedded in the resinous material and present as separate particles. This may suggest that its presence was not just due to a superficial smoking of the surface but was either intentionally or unintentionally included in the mixture.

Clay and Silicates

As with the other mask, the surface of this mask included silica containing compounds as determined by PLM, XRD, FTIR, and SEM-EDX. PLM of the dispersion samples from this mask included transparent crystalline particles both embedded in the matrix and separate. Some of the particles are probably quartz and others may be phytoliths, for reasons discussed above. The presence of quartz was also confirmed with XRD on samples of the surface. In FTIR spectra taken of surface particles in transmission, the quartz doublet at 800 cm^{-1} from the O-Si-O bend also appeared.

The two cross section samples from X77.392 were imaged using back-scattered scanning electron microscopy. The samples from the upper and lower surfaces have very different contents, based on the BS-SEM images. The upper sample has many rounded particles that look similar to the quartz particles from the other mask. EDX was not available at the time to confirm the composition of the particles, however the other techniques used strongly suggest that some of the particles are quartz.

As with the surface of X86.385, XRD and FTIR of the surface of this mask suggest that it may include clay or soil. As discussed above, the XRD results had a strong quartz spectrum and, similar to the other mask, the additional peaks did not exactly match any of the reference spectra. However, the closest matches were clays which is in agreement with results from other analyses on applied surface on objects from a nearby region (Mazel et al. 2008; Mazel et al. 2006).

Pesticide

Unlike X86.385, the XRF analysis of this headdress' surface had a strong peak for bromine. XRF results are best described as qualitative/semi-quantitative, and cannot support quantitative statements based on them. However, the relative size of the bromine peak was significant, especially when compared with the relatively small bromine peak for the other mask. This mask also had many dead insects emerging from crevices in the surface encrustation as well as tangled in its quills. The presence of such a large number of dead insects as well as the bromine peak may indicate the use of methyl bromide as a pesticide. None of the other inorganic pesticides typically found on ethnographic objects (mercury, arsenic, or lead) were present.

Some materials not present:

It may also be interesting to note the materials that were not present in this mask. These include the red iron rich particles that were found in the previous mask's surface. Additionally, chemical spot tests for chlorides, sulfates and nitrates were all negative. The surface of this mask also does not seem to include detectable levels of excrement based on evaluation with PLM, SEM, and FTIR.

<u>Manufacture</u>:

The two cross section samples were photographed with reflected light and magnification (Figure 7). Reflected light microscopy could not be used to differentiate materials or layers in the samples due to the lack of color differentiation and opacity of the material. The plant fibers trapped on the bottom of the samples are visible, but none of the internal plant fibers are visible. White areas in the reflected light image are places where large particles were unintentionally removed during sample preparation: the movement of polishing the sample could have flicked out the larger particles and then filled the resulting cavities with dust from the embedding epoxy. Unlike the mixture from the previous mask, no particles are visible in the samples, such as quartz or red pigment particles.

The back-scattered SEM analysis (Figure 16) in conjunction with visual observations can help to understand the manufacturing of the headdress's surface. There does not seem to be a distinct layer at the bottom of the lower cross section indicating a preparatory material applied to the mask prior to the surface. However, if the surface mixture was applied while the preparatory material was still wet, the two could have mixed. The lower surface layer is made up of a network of plant fibers with an organic matrix and seems to be a single application. Between the lower surface and the upper surface is a layer of unbound plant material. The upper surface cross section has some plant material embedded in its lowest layer but none in the surface material. Like the lower cross section, the upper cross section also seems to be a single application without internal layering.

Conclusions

The question of how to treat applied surfaces such as those on *komo* headdresses was initially raised by Mellor (1992) in his article on the ethical issues in the conservation of African objects. He asked whether we should "secure detached fragments of sacrificial patination on a Bamana *komo* headdress, when the amount and thickness of this incrustation are directly related to the degree and effectiveness of its cultural power?" In fact, as the results of the survey conducted as part of this research point out, North American conservators have stabilized these masks using materials similar to those used to stabilize intentional coatings. Conservators reflect on a principle of cultural and material understanding in approaching treatment, but lack access to this information. This study sought to develop an answer to this question within the cultural contexts of the masks in West Africa and in America, supplemented by scientific analytical techniques to identify the surface materials.

In conservation, identification of materials plays an important initial role in treatment decisions. Depending on the composition of the object, different adhesives, consolidants or support materials are chosen. In the case of these *komo* masks, however, importance of cultural considerations should take priority over precise material identification. Identification of materials used in the surface of these masks is restricted knowledge within the context of the *komo* power association. Due to a desire to respect the objects' cultural context and a concern about how results of this study could be used, I minimized the specificity of the results. The materials identified through this analysis have all been previously published in ethnographic accounts of the masks. Therefore, I presented my discussion of the results to correspond with the level of specificity in the ethnographic literature.

This study has found evidence of sequential applications to the surface. In the case of one mask, these layers were present within the applied surface. The other mask had two surface mixtures applied to it that were made with different materials. The analytical techniques identified the presence of blood, plant materials, charred plant materials, silicates, clay and a carbon rich matrix material (Table 12). Kola nuts and millet flour may be present in the mixture but were not conclusively identified. The charcoal or charred plant materials may be a result of the smoking of the headdress' surface as found in the ethnographic literature.

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 (Gagliardi 2010: 159; McNaughton 1993: 133). Neither do the results give any indication of the method for harvesting or preparing the materials—other aspects of the secrets around the masks' construction. Headdresses made during different time periods and in different places could include different materials. However, these results can act as an initial guideline for understanding the applied surfaces.

The success of different techniques for identifying materials varied. Polarized light microscopy was very helpful for an initial characterization of the material. It can help to determine whether the surface contains inorganic particles and / or plant fibers. FTIR was helpful for identifying some of the materials, but could not provide as much information about the organic components as expected. XRD was also not as helpful as expected since only quartz had a crystalline structure that was able to give an identifiable spectrum. Reflected light microscopy of polished cross sections was very unhelpful due to the opacity of the material and its uniformity of color. This technique could be modified to be more helpful if thin sections could be viewed in transmission. The backscattered SEM and EDX images were very helpful for viewing the polished cross sections' structures and the elemental compositions.

My research into the ethnographic literature did not provide much information about the appropriateness of treatment for these surfaces. Jespers (1995: 44) mentions that changes in the condition of the mask or its surface between performances were interpreted as communication of living entities from the spirit world to the members of the power association. In contrast, art conservators interpret changes as signs of aging and deterioration to be minimized, mitigated, and reversed through treatment.

An appropriate material to use on an applied surface should not discolor or change as it ages and not alter the aesthetic properties of the surface while providing increased cohesion within the material and adhesion to the wood substrate. The difference in the material compositions and structures of the samples taken from these two masks strongly suggest that caution should be used when testing consolidants on the surfaces of these objects. An additional reason for caution is the possibility that the solvent in the embedding medium could have solubilized and removed the long chain hydrocarbon from the sample. Visually identical surfaces may be composed of various materials and may react differently to the same consolidant. In some applied surfaces, the high concentration of organic materials in the applied surface may have caused the distinctive craquelure pattern on its surface.

The application of any foreign materials to the object is not a neutral activity: our actions invariably prioritize certain characteristics (e.g. the aesthetic) over others (e.g. the spiritual). While we may be able to identify a material that does not change the appearance of the object, it alters the composition of the surface and therefore may change the power of the headdress. The addition of a modern material to an object can create a sort of hybrid (Matero 2011; Muñoz-

Viñas 2011). Due to the complexity of the surfaces, their treatment should be done carefully and conservatively, with an emphasis on preventive techniques necessary for the long-term stability of the object, such as environmental control given the high concentration of organic material present in the surface and their role in its instability.

Tables

1. List of museums which have Komo masks or other similar masks

Museums with *Komo* Masks (listed alphabetically)

Afrika Museum, Berg en Dal, Netherlands
American Museum of Natural History
The Baltimore Museum of Art
Bowers Museum of Cultural Art, Santa Ana
British Museum
Brooklyn Museum
De Young Fine Arts Museum of San Francisco
Detroit Institute of Art
Fowler Museum
Haffenreffer Museum of Anthropology, Brown University
Herbert F. Johnson Museum of Art, Cornell
Indiana University Art Museum
Indianapolis Museum of Art
Lowe Art Museum, University of Miami
Metropolitan Museum of Art
Musee du Quai Branly
New Orleans Museum of Art
Royal Museum for Central Africa, Belgium
Seattle Art Museum
Dallas Museum of Art

Museums with *Kono*, or *Boli* (not exhaustive list)

Art Institute of Chicago
Cantor Center for Visual Arts, Stanford University
Hood Museum of Art, Dartmouth
Los Angeles County Museum of Art
Menil Collection, Houston
Michael C. Carlos Museum (Emory University)
National Museum of African Art
St. Louis Art Museum
Yale University Art Gallery

2. Table of materials found on Komo masks based on literature review

Reference	Blood	Millet	Kola nuts	Clay	Plant gum	Bone (crushed)
McNaughton 1979; 26, 44	Y	Y	Y	Y		
Imperato 2009; 182, 184	Y	Y	Y		Y	
Dieterlen 1972 in Lamp 2004; 232	Y	Y		Y		Y
Colleyn 2009; 36	Y	Y	Y		Y	
Jespers 1994; 51	Y			Y	Y	Y
Brett-Smith 2001; 127	Y	Y				

3. Conservation survey of Komo masks

Survey Of Conservation Approaches to the Applied Surface on *Komo* Masks

Please complete the survey and return to robinohern@ucla.edu by March 1st, 2011

Museum:
Accession Number:
Year Accessioned:

1. Is there documentation of previous treatments to the *Komo* mask(s) in your collection?
   _Yes / _ No

2. Have the *Komo* mask(s) received conservation examination since you were on staff?
   Yes / No

3. What type of analysis, if any, has been done on the object or the object's surface?

Method	*Yes/No*
X-Radiography	
X-ray Fluorescence	
X-ray Diffraction	
Fourier Transform Infrared Spectroscopy	
Gas Chromatography Mass Spectrometry	

4. Based on the treatment record or observations, do the previous treatments to the surface of the *Komo* mask include any of the following?

Treatment	*Yes/No*	*Materials Used:*
Surface Stabilization		
Loss compensation		
Structural support		
Other		

5. Aside from the surface, have there been other interventions to other components (horns, porcupine quills, metal nails, feathers, wood)? If yes, please explain the type of intervention and materials used (if known):

6. Before considering any treatment, what information (conservation, cultural, curatorial, etc.) would you want to know about the surface?

7. Based on current conservation philosophy, would you now stabilize areas of incipient surface delamination? If so, what materials would you use? What considerations (conservation, cultural, curatorial, etc.) would be discussed?

8. Would you complete loss compensation? If so, what materials would you use? What considerations (conservation, cultural, curatorial, etc.) would be discussed?

4. Experimental

Chemical Spot Tests

Chemical spot tests to generally characterize the surface were performed on pieces of the surface that have already become detached from the object. These spot tests include solubility tests and tests for protein, blood, and starch. The spot tests were done on cleaned glass slides and examined under the stereo microscope.

Polarized Light Microscopy

Melt mount: Cargill (RI 1.668)
Microscope: Olympus BX51
Camera manufacturer: Nikon D90 and Nikon D70
Photographing program: Camera Control Pro2
Sample used: small particles that had separated from the masks. One sample from each mask was crushed and mounted as a dispersion in the Melt mount.

X-Ray Diffraction

Instrument: R-Axis Spider
Copper target, mounted on glass spindle
Identification software: Jade
Rint Rapid Software
50Kv and 40mA
Sample used: small particles that had separated from each of the masks. The XRD was run on a rotating particle, on a plane of the particle, and on a crushed sample.

Fourier Transform Infrared Spectroscopy

Perkin-Elmer Spectrum One infrared spectrometer in Attenuated Total Reflectance (ATR) mode with a Zn-Se crystal.
The spectra acquired over the range of 4000-530 cm-1 and then compared with spectra in the UCLA/Getty Conservation Program's IR database, and in the Infrared and Raman Users Group (IRUG).
Resolution: 4.00 cm $^{-1}$
Scan time: 32 scans
Software program: Spectrum V3.3
Samples used: This instrument was used to analyze the reference materials only.

Hyperion 3000
ATR Diamond 80 micrometer facet
Sample used: Two small (2mm x 2mm x 1 mm) samples were removed from the surface of X77.
Samples used: (1) small particles from the applied surface of each mask, crushed on a diamond plate. (2) Cross sections of the surface material.

Portable X-Ray Fluorescence

XRF Instrument and Model No.: Tracer III-V
Manufacturer and Serial No.: Bruker K0466
Source: Rhodium

Settings: The spectra for the surface were collected at 40 kV, 1.35 mA with no filter and with a vacuum.
Sampling: This technique is non invasive and so no samples were removed. The surface of the masks and nails were analyzed by placing the instrument detector as close as possible to the surface. The kola nut chunks were analyzed by placing the chunks on the window of the instrument. The kola nut powders were analyzed by placing a small amount of powder in a Mylar tray (Mylar being transparent to x-rays) so that the sample covered the instrument window.

Scanning Electron Microscopy
Instrument: Nova 230 Nano SEM
Low vacuum mode
Detector: Gaseous Analytical Detector
Software: xT microscope control software
Samples used: All four polished cross sectional samples of the two masks

5. Table of reference materials sources and preparations

Reference Material	Material preparation based on literature review	Reference Material Source	Notes on source	Analytical Technique
Kola nut Chunks (*cola acuminata*)	The nuts were masticated or crushed before application (McNaughton 1979b: 26).	Mountain Rose Herbs Mountainroseherbs.com	Wild harvested[8] From Ivory Coast	XRF, FTIR
Kola nut Powder (*cola acuminata*)	The nuts were masticated or crushed before application (McNaughton 1979b: 26).	Mountain Rose Herbs Mountainroseherbs.com	Wild harvested From Ivory Coast	XRF, FTIR
Kola Nut Powder (*Cola nitida*)	The nuts were masticated or crushed before application (McNaughton 1979b: 26).	Bouncing Bear Botanicals[9]	From Ghana "The seeds of Cola nitida are taken from the pods and their outer coat is removed."	XRF, FTIR
Millet Flour	"The *dege* that is used on *komo* masks is liquid in consistency and is made by mixing the powder with large amounts of either water or milk. The result is a thin gruel that ferments and becomes alcoholic when stored for a period of time." (Imperato 2009, 185)	Bob's Red Mill	Whole Grain Stone Ground	FTIR
Blood	The applied blood came from chickens, goats, sheep or cattle (Imperato 2009b: 179).	IRUG database	Dried, aged blood	FTIR

[8] "**Wild harvested-** Items gathered from their natural environment, such as woodlands, prairies, deserts etc. All wild harvested items are taken to separate facilities for further processing. All wild harvested items gathered and contracted for Mountain Rose Herbs must sign a preliminary "Wild Take Audit" to insure that materials are sustainably gathered with a no more than 10% take, and that the plants are re-seeded or roots are left to re-stock native populations." From http://www.mountainroseherbs.com/bulkherb/k.php#h_k_n

[9] "All of the Ethnobotanicals available from this site are sold for research, education and propagation purposes only."

6. Spot tests experimental

Test	Procedure
Test for chloride using silver nitrate (Odegaard et al, 2005)	1. place sample in test tube or on glass slide 2. add 5-8 drops distilled water 3. add 2 drops HNO3 (nitric acid) 4. add a drop of silver nitrate (0.2M) POSTIVE: cloudy white precipitate Note: pin head sized amount of pure NaCl tested positive with 1 drop water, 1 drop nitric acid, 1 drop silver nitrate, as did a ¼ pin head sized amount.
Test for nitrate using Iron(II) sulfate (Odegaard et al, 2005)	1. place a small particle in test tube or glass slide 2. add a drop of concentrated sulfuric acid (H2SO4) 3. add a drop of iron II sulfate solution (in water) POSTIVE: brown color forming around sample nitrate
Test for sulfate using barium chloride (Odegaard et al, 2005)	1. place sample on a dark glass slide 2. add a few drops water 3. add a few drops 3M HCl 4. check pH to make sure solution is acidic 5. add 2 drops 2M BaCl2 solution 6. wait a few minutes POSITIVE: look for white precipitate
Test for starch using iodine/potassium iodide (Odegaard et al, 2005)	1. grind sample to fine powder 2. place on glass slide 3. place a drop of KI3 solution on sample POSTIVE: *strong* blue color Iodine/potassium iodide (KI3) solution: add 0.9 g potassium iodide (KI) to about 5mL distilled water and then add 0.04 g of iodide (I2) to the KI solution. Allow to fully dissolve. Then dilute to 35mL with distilled water.
Test for heme group of blood using phenolphthalein (Nieuwenhuizen, L. 1994)	1. add a single drop of phenolphthalein working solution to sample. 2. Add a single drop of 3% hydrogen peroxide POSITIVE: a pink color within 10-15 seconds (no more) To make test solution: Place 2.0 g phenolphthalein, 20.0g sodium hydroxide, 20.0g zinc granuels and 100 mL distilled water in flask. Secure to a reflux apparatus. Reflux 2-4 hours until resulting solution is colorless. Refrigerate stock solution over zinc granules in an amber container. For a working solution, prepare as a 1:5 dilution with ethanol.

Test for Protein using Ninhydrin (Nieuwenhuizen, L. 1994)	1. mix 0.14 g sodium hydroxide with 0.43 g citric acid in 49 ml distilled water 2. dissolve 0.5 g ninhydrin in 49g methyl cellusolve 3. combine two solutions 4. add 0.57 g Activol DS and shake 5. place a drop on the sample, allow to soak for several minutes 6. blot off excess with filter paper 7. heat the sample on hot plate or alcohol flame until dry POSITIVE: red, violet, or blue-grey color indicates protein
Test for Protein using aniline blue (Nieuwenhuizen, L. 1994)	1. place sample on glass slide with cover slip 2. fill air gap with water 3. place a drop of 0.1% aniline blue (aqueous) on the material or next to the cover slip 4. draw aniline blue through by placing a small piece of torn blotter paper against the cover slip edge at opposite side 5. observe under microscope POSITIVE: BLUE will stain protein
Test for Simple Sugars using o-toluidine (Stulik and Florsheim, 1992)	1. place 5 mg finely ground sample in 3mL flat-bottomed vial 2. add 10 drops of distilled water 3. boil gently in water bath on hot plate for 1-2 minutes 4. cool to room temp 5. transfer liquid to micro-centrifuge tube and spin for 1 minute 6. mix 3 drops of supernatant with 0.5 mL of the o-toluidine reagent 7. heat in the boiling water bath for 10 minutes POSTIVE: blue-green color
Test for Complex Sugars using o-toluidine (Stulik and Florsheim, 1992)	1. place about 5 mg sample in a 3 mL screw-cap vial 2. add 0.5 mL (10 drops) of the H2SO4 solution and close tightly 3. heat in a 100C oven for 2 hours 4. remove vial from oven, cool, transfer contents to micro-centrifuge tube 5. centrifuge for 1 minute 6. place 2 drops of the supernatant into the screw cap vial 7. add one drop of the 7.5 M NH4OH solution. Test pH should be neutral 8. add 0.5 mL (10 drops) of o-toluidine 9. place in boiling water bath for 10 minutes

7. Table of spot test results

Test For:	Methodology	Known Positive:	X77.392	X86.385
Chlorides	Silver Nitrate	pin head sized amount of pure NaCl tested positive with 1 drop water, 1 drop nitric acid, 1 drop silver nitrate, as did a ¼ pin head sized amount.	*Negative* No white precipitate	*Negative* No white precipitate
Nitrates	Iron(II) sulfate	¼ pin head sized sample of sodium nitrate – brown color	*Negative* No brown color	*Positive* A few areas of brown color around some particles
Sulfate	Barium Chloride	¼ pinhead sized amount of sodium sulfate – no precipitate pinhead size – white precipitate	*Negative* No white precipitate	*Negative* No white precipitate
Starch	Iodine/ Potassium Iodide	Paper towel- turned blue	*Possibly* Some black/bluish particles, but these could be from the saturation of materials in the surface	*Possibly* Some black/bluish particles, but these could be from the saturation of materials in the surface
Blood	Phenolphthalein	Animal blood (from spot test kit)	Top layer: *Negative* No pink color Lower layer: *Positive* Turned pink	*Positive* Sample swab turned pink
Protein	Ninhydrin	Rabbit hide glue – positive (must wait a long time for result)	*Possibly* Some reddish particles, but may not have been a color change from their original reddish color	*Possibly* Some reddish particles, but may not have been a color change from their original reddish color

8. Table of FTIR bands from the surface material analysis

Material	Diagnostic peaks (cm^{-1})		Peaks in data for X86.385 (cm^{-1})	Peaks in data for X77.392 (cm^{-1})
Dried, Aged Blood	Amide I	1645	1650*	1650*
	Amide 2	1536	~1540*	1536*
Kaolinite	Elongation of the O-H (doublet)	3700 3622	3697 3620	3697 3620
		1118	-	-
		1032	1037*	1032*
	Si-O stretching	1008	1008	1008*
	Deformation of the Al-Al-O-H band	914	915	912
Quartz	Si-O stretch	1077*	1080	1072 (shoulder)
	O-Si-O bend (doublet)	798 780	798 781	798 781
		698	696	698
Burnt Sienna		3365		
		1038	1037*	1037*
Chrysotile		960	x	958
		~660	x	670
Kola Nuts		1614	-	-
		1148	1153? shoulder	-
	Glycosidic linkage	1076	1080 (shoulder)	1080 (shoulder)
		1015*	1012 (shoulder)	1008* (shoulder)
Millet Flour		1709	-	-
		1645	1650*	1650*
		1533	~1540*	1536*
		1149	1153? shoulder	-
	Glycosidic linkage	1077	1080 (shoulder)	1080 (shoulder)
		999*	998? (shoulder)	-
Long chain hydrocarbon (Oil or wax)	Methylene bands	2926 2855	2958 2926	2958 2926

(* indicates overlapping peaks that could indicate more than one material)

9. Table of XRF Data for the Two Komo Masks and the Kola Nuts

("x" indicates that the element was present)

	X77.392	X86.385	Kola Nuts
Si	X	X	
S	X	X	X
K	X	X	X
Ca	X	X	X
Ti	X	X	X
Mn	X	X	X
Fe	X	X	X
Br	X	X	
Sr	X	X	X
Zr	X	X	

10. FTIR-ATR results for layers in Samples 1 of X86.385

Table of FTIR-ATR results for Sample 1 (X86.385)
("X" indicates the presence of a material)

	Protein	Long Chain Hydrocarbon (ex: oil)	Clay	Silicates (including Quartz)	Embedding Medium
Identifying wavelength	1645 cm^{-1}	2922 / 2852 cm^{-1}	1008 cm^{-1}	798 / 780 cm^{-1}	1720 cm^{-1}
Layer 1	X	X	X	X	
Layer 2	X	X	X		
Layer 3	X	X	X		
Layer 4	X	X	X		
Layer 5	X	X			
Layer 6	X	X			
Layer 7	X			X	X
Layer 8	X				X
Layer 9	X				X

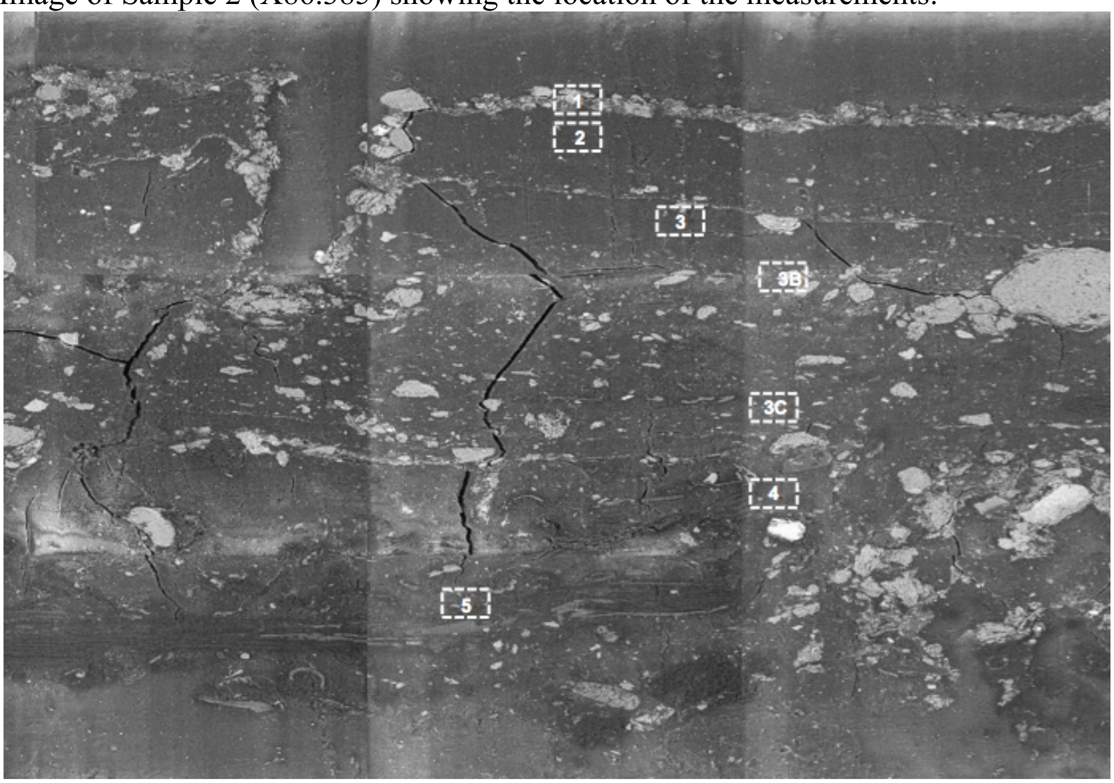
Image of Sample 1 (X86.385) showing the location of the measurements:

11. FTIR-ATR results for layers in Sample 2 of X86.385

Table of FTIR-ATR results for Sample 1 (X86.385)
("X" indicates the presence of a material)

	Calcite	Protein	Long Chain Hydrocarbon (ex: oil)	Clay	Silicates (including Quartz)	Embedding Medium
Identifying wavelength		1645 cm^{-1}	2922 / 2852 cm^{-1}	1008 cm^{-1}	798 / 780 cm^{-1}	1720 cm^{-1}
Layer 1	X			X		X
Layer 2		X		X		X
Layer 3		X	X			X
Layer 4		X	X			
Layer 5		X	X		X	

Image of Sample 2 (X86.385) showing the location of the measurements:



12. <u>Table of results for components of the surface materials</u>

Material	Identifying technique	Present in surface of X86.385	Present in surface of X77.372	Expected based on the literature	Comments
Kola Nuts	FTIR	Probably	Probably	Yes	Can not differentiate from millet flour, and results are masked by quartz bands
Millet Flour	FTIR	Probably	Probably	Yes	Cannot differentiate from kola nuts, and results are masked by quartz bands
Blood	FTIR, spot tests	Yes	Yes	Yes	Can not say definitively that the protein from FTIR is blood but the spot tests for blood gave positive results
Clays	XRD, SEM-EDS	Yes	Yes	Yes	Likely an alumino-silicate clay
Quartz	XRD, SEM-EDS, FTIR	Yes	Yes	Not mentioned	Can be added separately or as part of the clay material
Charcoal	PLM	Yes	Yes	Somewhat	One source, (Colleyn 2009, 36) mentions charred plants being in the surface

Figures

Figure 1: Overall image of X86.385 from the Fowler Museum

Figure 2: Detail of the surface of X86.385 showing the areas of loss to the surface material and exposed wood

Figure 3: Image of X77.392, mask from the Fowler Museum

Figure 4: Detail of the surface of X77.392 showing the two layers of applied surface with plant material between them

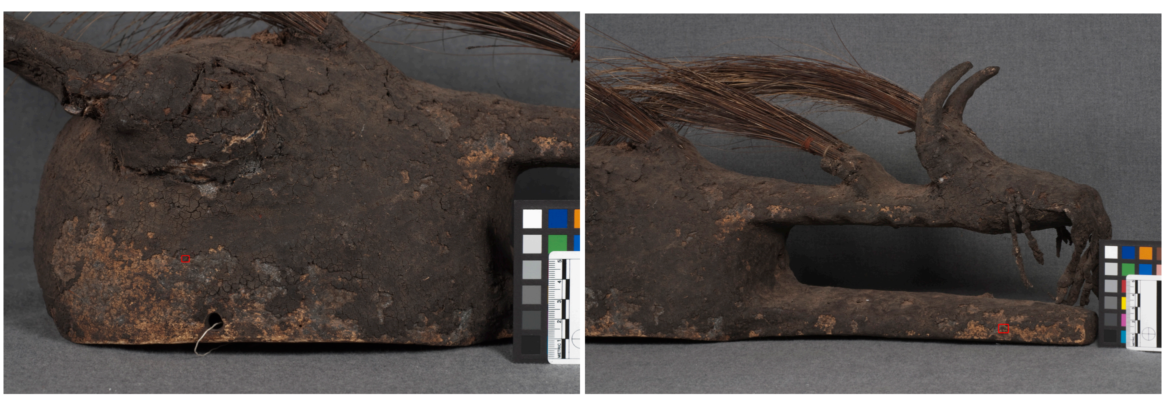


Figure 5: Image showing the location of the samples removed from the head of X86.385 with red rectangles. Left: sample 1; Right: sample 2

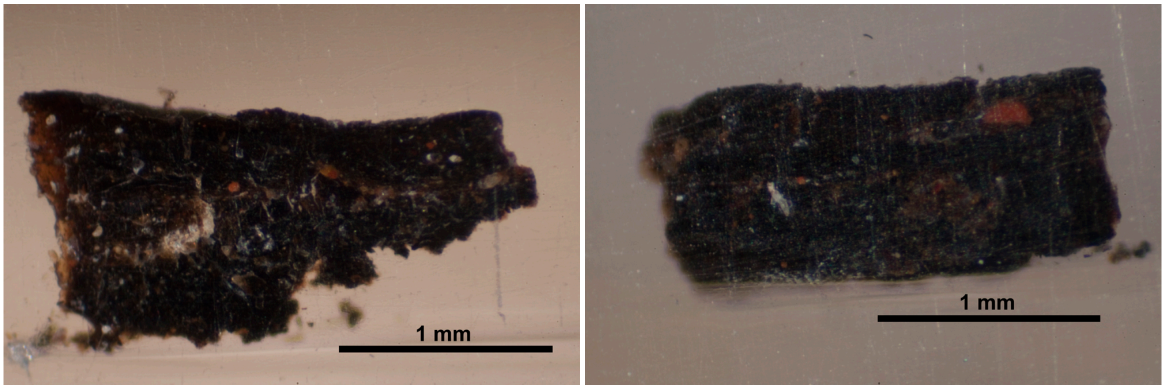


Figure 6: Left: Image of polished cross section sample 1 from head of X86.385. Right: Image of the polished cross section sample 2 from the mouth of X86.385

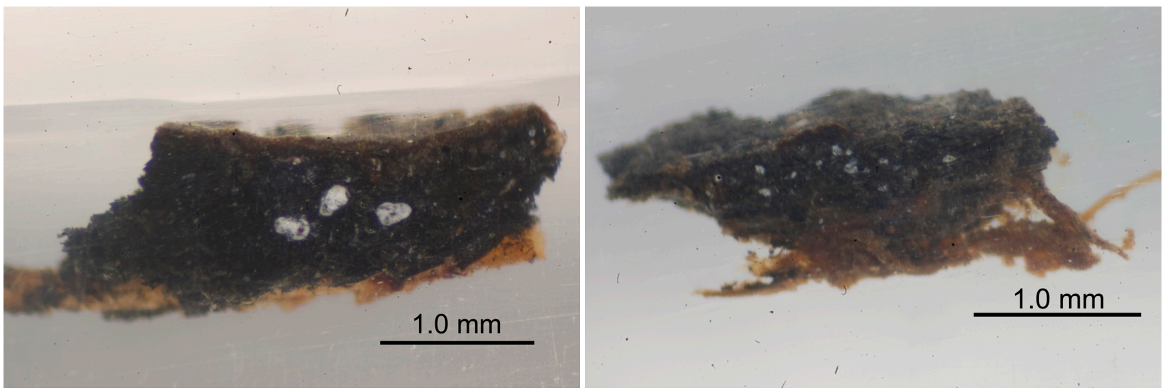


Figure 7: Left: Image taken in reflected light of the upper cross section (sample 3) from X77.392. Right: Image taken in reflected light of the lower cross section (sample 4)

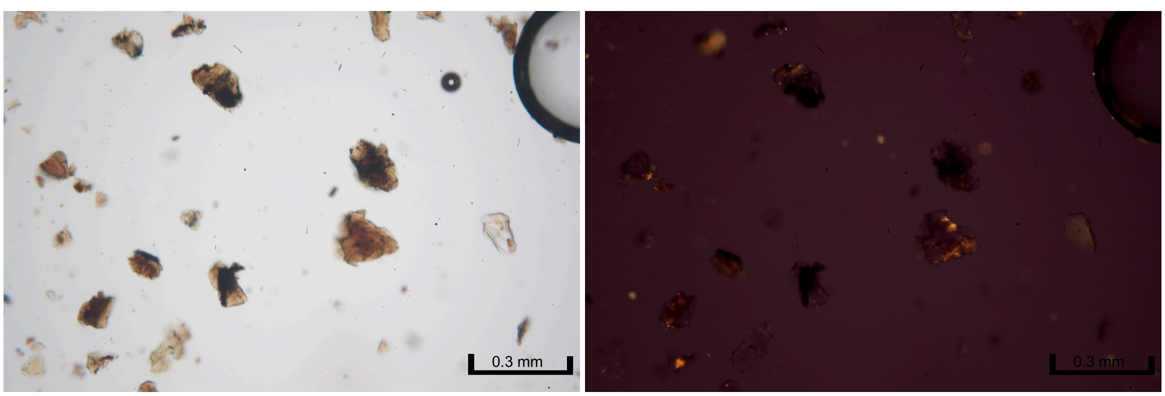


Figure 8: PLM image of mounted dispersion sample from X86.385. Left: transmitted light; Right: cross polarized light.

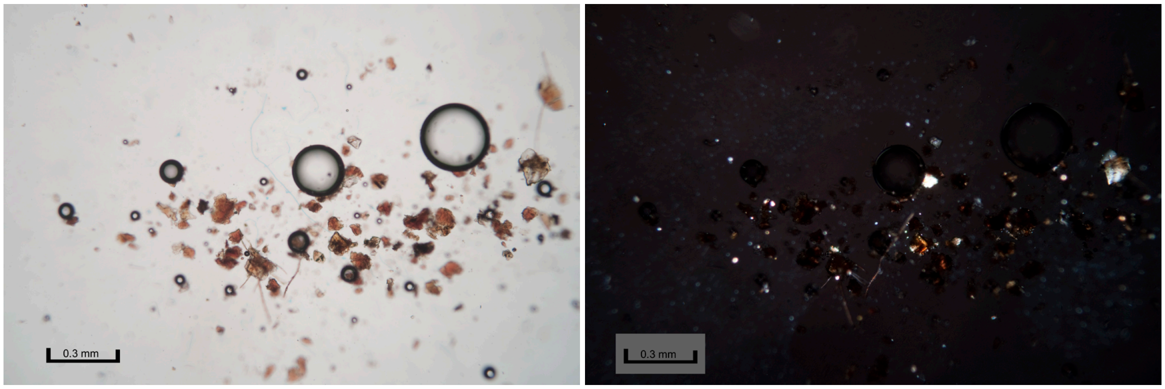


Figure 9: PLM image of mounted dispersion sample from X77.392. Left: transmitted light; Right: cross polarized light.

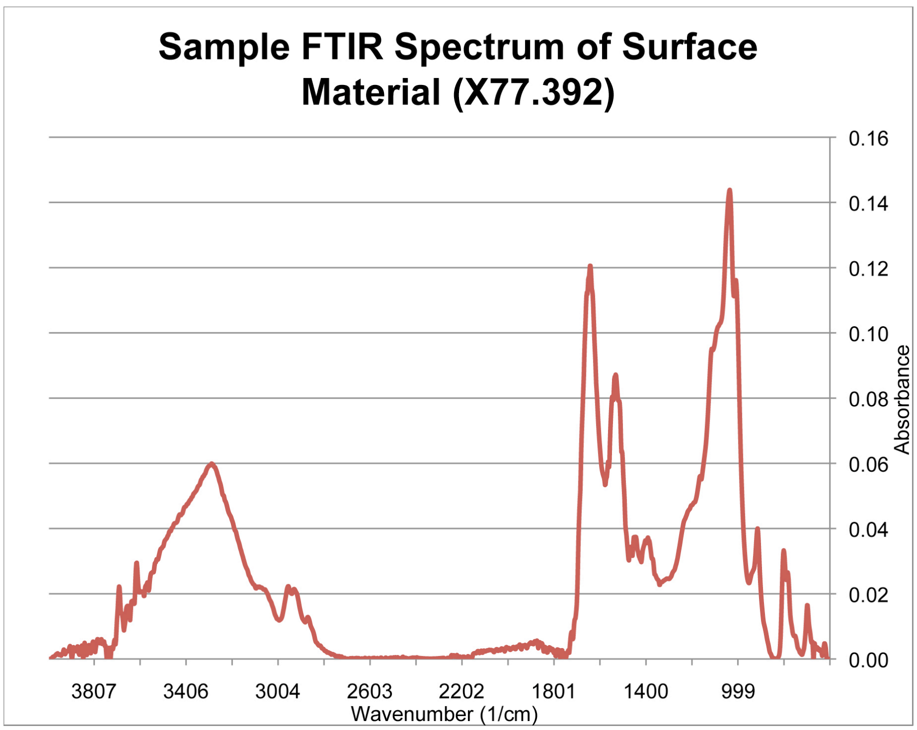


Figure 10: Example of a FTIR spectrum of a surface scraping taken from X77.392.

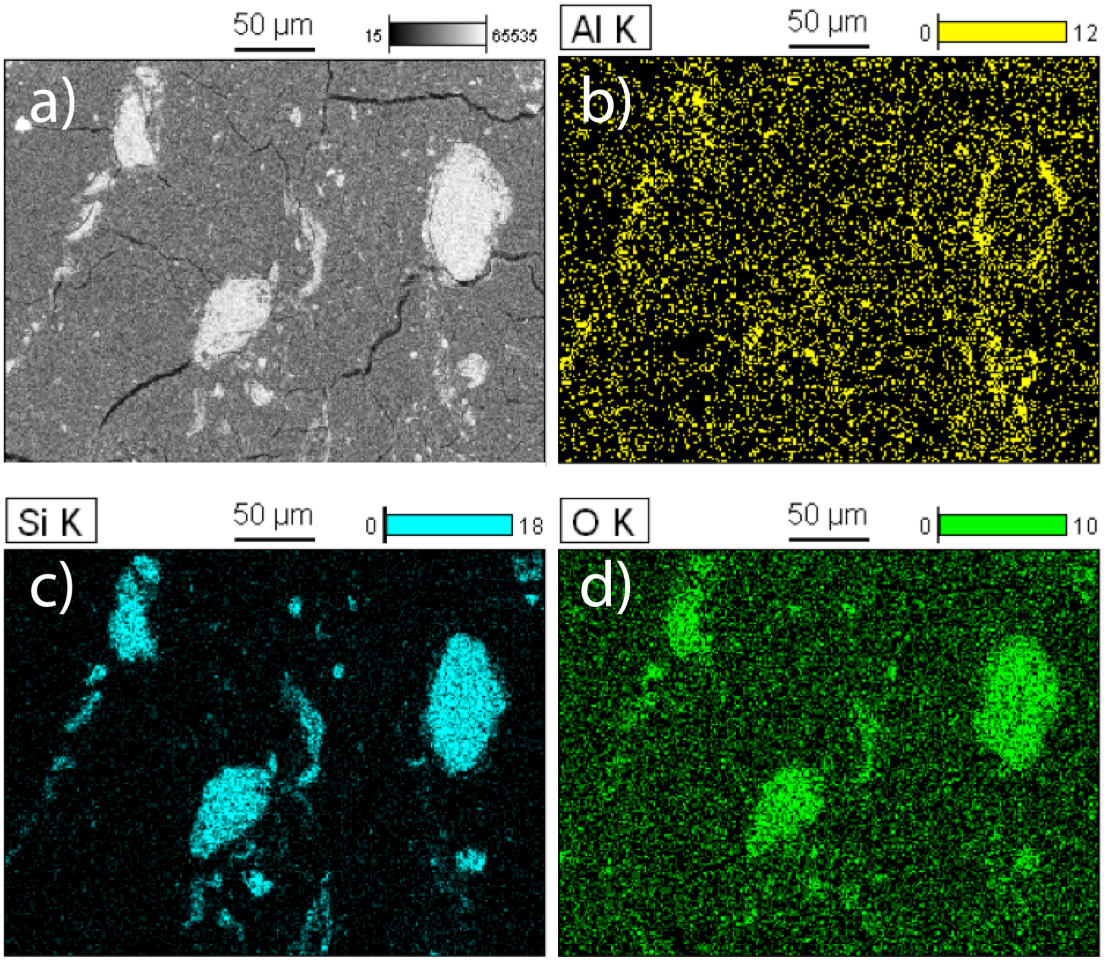


Figure 11: SEM-EDX images of detail from sample 2 (X86.385). a) grey scale image of the back scattered SEM detail area; b) elemental map of aluminum (Al) showing a even distribution with some areas of concentration around the white particles in (a); c) elemental map of silicon (Si) with areas of concentration matching with the white particles in (a); d) elemental map of oxygen (O) with areas of concentration matching with that of silicon.

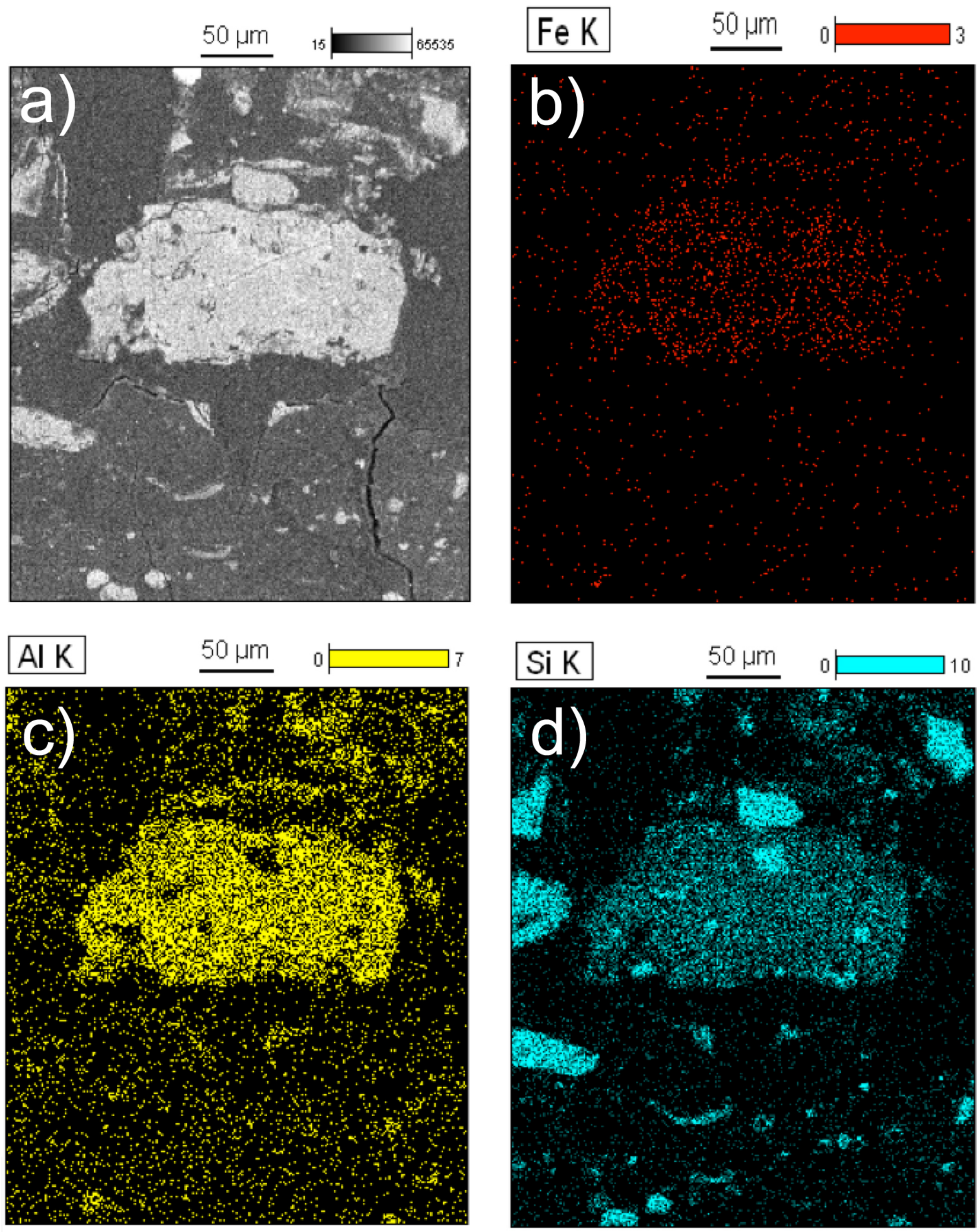


Figure 12: SEM-EDX images of a cross section detail from sample 2 (X86.385) showing one of the large red particles in the center of the detail image. a) grey scale back scattered SEM image of the detail area in which the white particle is the red particle on the cross section surface; b) elemental map of iron (Fe) showing a concentration in the red particle; c) elemental map of aluminum (Al); d) elemental map of silicon (Si).

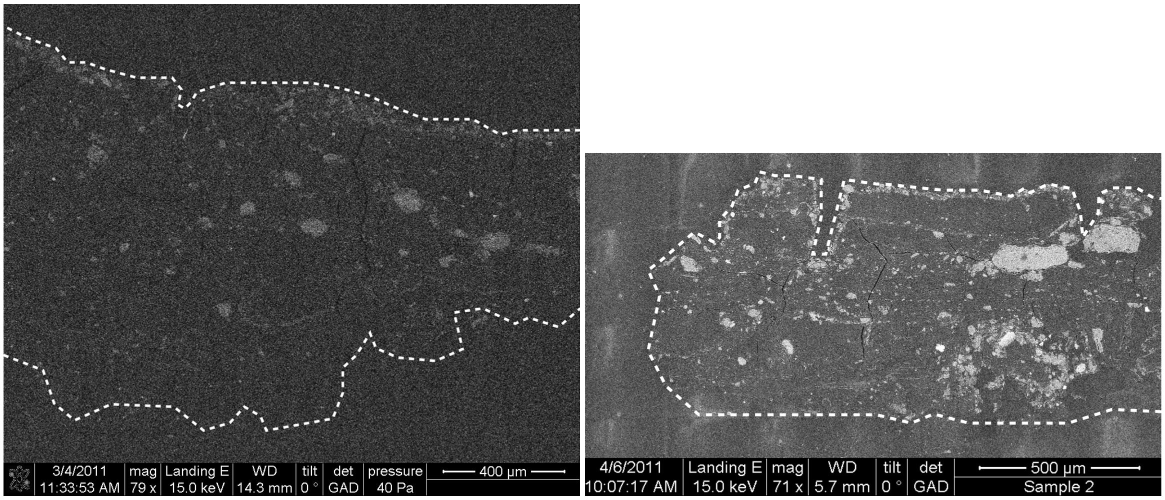


Figure 13: Back scattered electron image of sample 1 (left) and sample 2 (right) from X86.385. The white dotted line indicates the periphery of the samples.

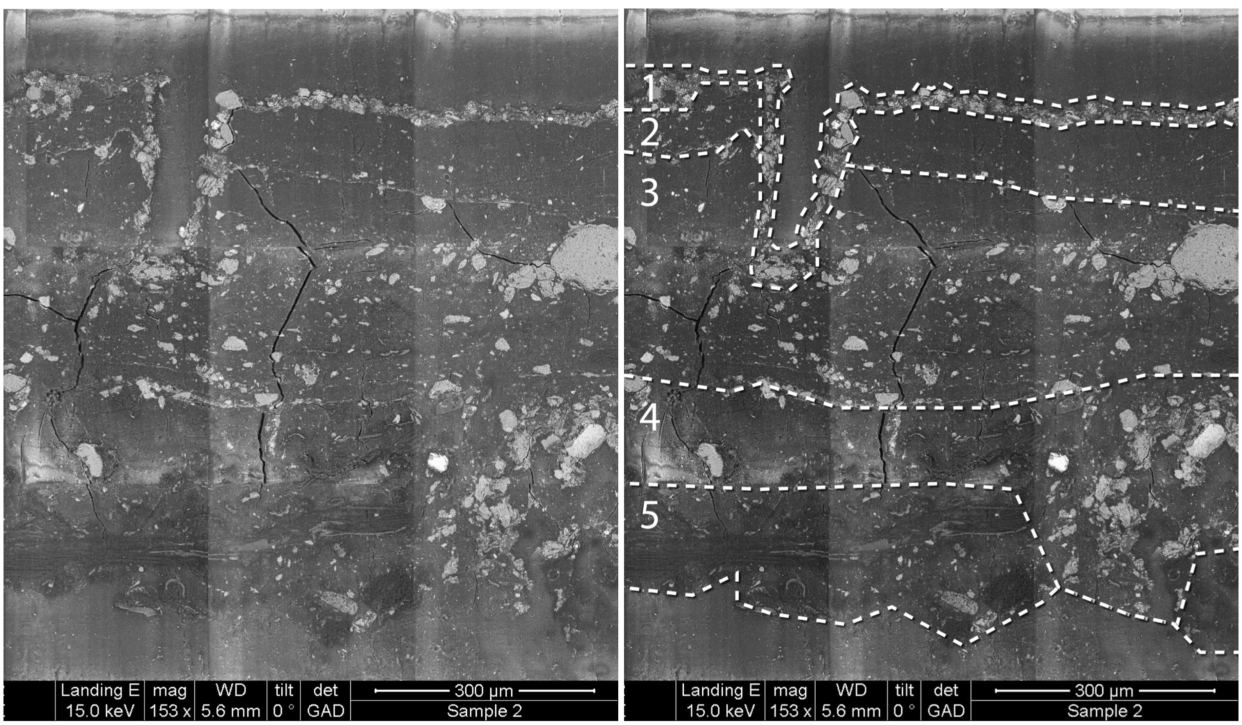


Figure 14: Detail back scattered SEM image of sample 2 (X86.385). The white dotted lines indicates the periphery of the sample edges and potential layers within the sample.

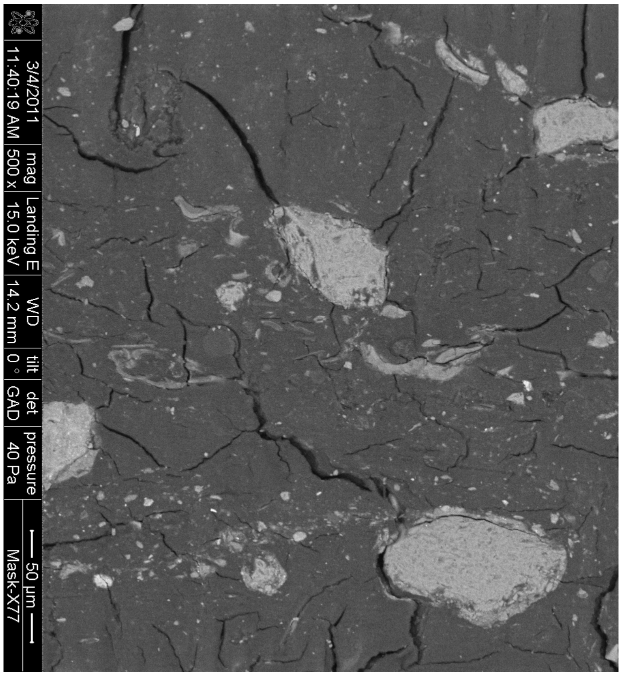
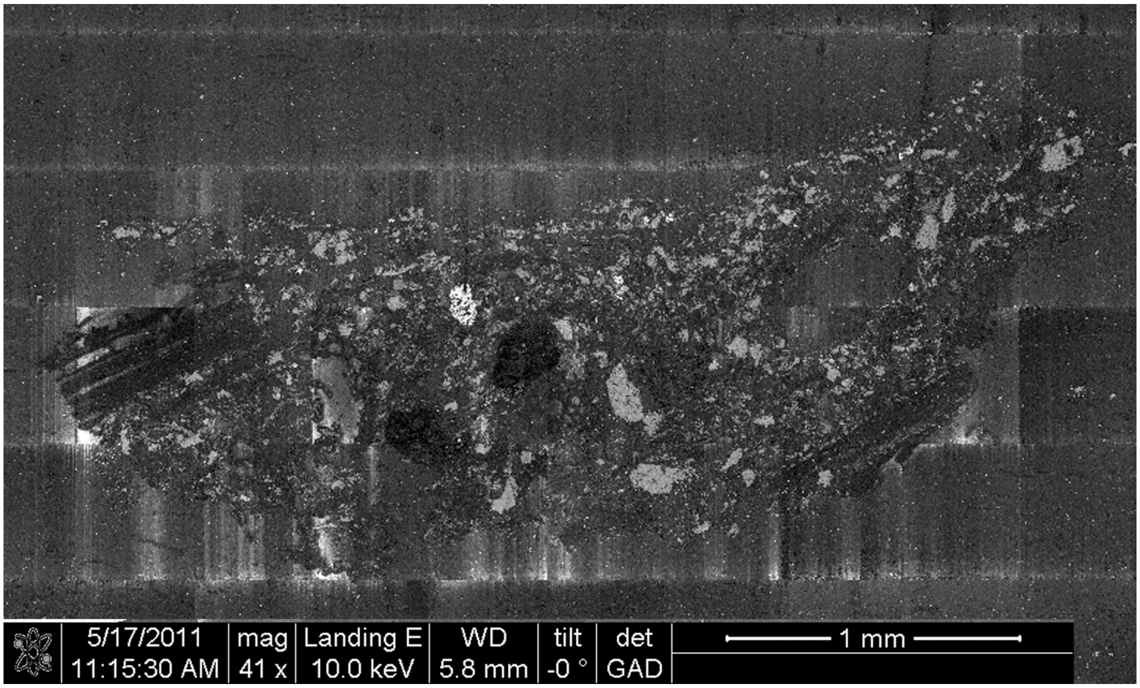


Figure 15: Detail back scattered SEM image of sample 1 from X86.385 showing the cracks in the matrix throughout the sample.



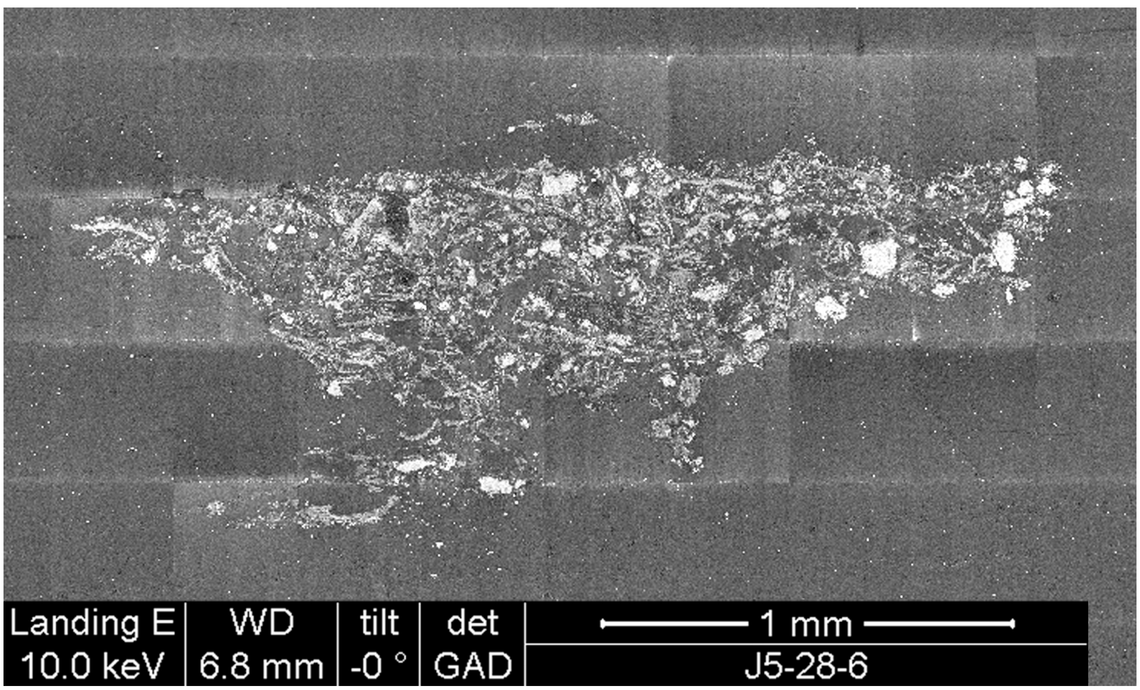


Figure 16: Upper: back scattered SEM image of the upper cross section (X77.392). Lower: back scattered SEM image of the lower cross section (X77.392).

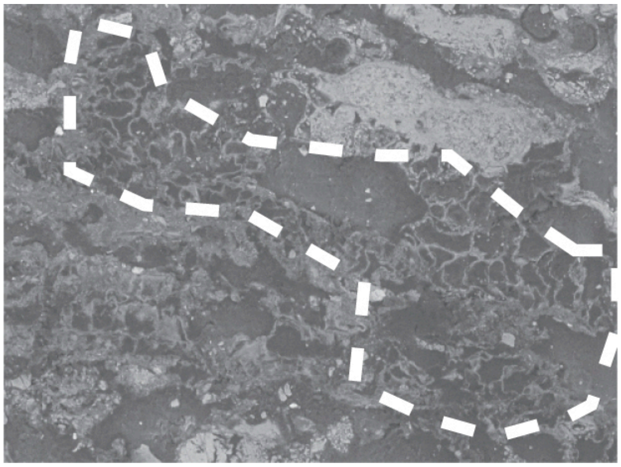


Figure 17: Detail of the BS-SEM image from the lower cross section (X77.392) showing possible plant cells outlined with a white dashed line.

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