DOI 10.17953/aicrj.43.1.ancheta

Revealing Blue on the Northern Northwest Coast

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Recognized around the world, the distinctive black, red and blue or green designs created by the Haida and Tlingit of the Northwest Coast of North America are iconographic of these cultures (fig. 1). As important and informative as the traditions of carving and weaving, the use of color as well as the materials, tools, and methods of making and applying paint need to be identified and correctly integrated with what we already know about the Haida and Tlingit cultures of the Northwest Coast to provide a more comprehensive picture of the past. The roles played within these cultures by the colors and materials on artifacts can be revealed more comprehensively when we understand the significance of specific materials. The study of color use, and pigment and paint technology, can provide new insights into the complex critical thinking and technical skills of individual artists, as well as the Haida and Tlingit cultures from which they came.

Identifying specific pigments can provide valuable information relating to provenance and authorship of artifacts and helps us identify sibling artifacts. We are better able to conserve the artifacts we hold according to the materials with which they are made if we have a full understanding of all those materials. Investigating the reasons for using specific colors such as blue, and the materials that make those colors, gives us new descriptive and interpretive information about daily life, sociopolitical standards, cultural practices, worldviews, and cosmologies of the Haida and Tlingit. While for two hundred years almost every other aspect of Haida and Tlingit life has been studied and remarked, references to the significance of color and the materials

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used to make color have been rare, and, in the case of the traditional blue paint, have been consistently incorrect. Early in the ethnographic study of the Northwest Coast traditional blue was mistakenly attributed to copper oxides, and subsequent scholars have persisted in making this claim without scientific verification.

This article brings together data and information about the color blue, and the blue mineral pigment vivianite specifically, and their roles in Haida and Tlingit societies. Because so little is known about vivianite, this paper is also an effort to bring the behaviors, and implications of these behaviors, of vivianite on Northwest Coast artifacts to the attention of conservators, museum staff, scholars, artists, and anyone involved in the creation, care, and storage of these objects. It is critical for this and future generations that these artifacts be cared for according to the materials with which they are made so they can be interpreted correctly, and continue to be a resource for learning now and in the future.

The art of the Haida and Tlingit cultures of the Northwest Coast of North America has relied on the ancient foundation of formline design characteristics for at least five thousand years. It has become one of the most identifiable and distinct art forms in the world.[1] During this time formline art has consistently adhered to its ancient foundation of design principles regardless of outside influences and events as well as cultural and population devastation. As an integral component of Haida and Tlingit art, the traditional color palette of black, red, blue and green has also persisted for millennia.[2] Even with the availability of an immense array of colors today, the traditional four-color palette remains part of the construct of the sociocultural architecture of Haida and Tlingit cultures. While other colors were used occasionally, there has been no consistent adoption of them into the core palette of black, red, blue and green, nor have any of the four traditional colors been replaced.

When commercially manufactured artist's materials and tools became available in Europe, western cultures moved away from material-driven artistic practices, and, in the process, dematerialized color. In contrast, on the Northwest Coast, the use of specific colors and the materials which make colors has persisted in material and cultural importance until today. Euro-American cultures also abandoned the necessity of understanding the materials and tools involved in making and using paint, completing the dismemberment of the fundamentals of western art. However, among Northwest Coast Native people, disease, assimilation, loss of traditional lands and practices, boarding schools, and sheer attrition took their toll, and the knowledge of the materials, including the reasons for using certain colors, was lost. Fortunately, because the Haida and Tlingit palette is so narrow, and because color is an integral component, not just of the art, but of the composition of Haida and Tlingit life, it is comparatively easy to piece together past knowledge and practices. Reconstructing this knowledge and applying it to our study of Northwest Coast cultures is integral to creating a congruent picture of their traditions, practices, and beliefs. Reintegrating it into these cultures is also essential to the persistence and continuity of their traditions.

An extensive search of current and historical Northwest Coast literature provided no analytical or reliable information about the materials traditionally used by Northwest Coast artists for blue paint. This article is a summation of more than

twenty years of research into the pigments, paint technology, and the use of color among Northwest Coast Native cultural groups. In the few brief mentions of the materials used for paint-making, the color blue has consistently been incorrectly attributed to copper compounds such as azurite (Cu3(CO3)2(OH)2, or celadonite, (K(Mg,Fe^{2+})(Fe^{3+},Al)[Si4O10](OH)2, which is a phyllosilicate of potassium.[3] Vivianite, azurite, and celadonite are quite distinct from one another in color (see fig. 3C and 3D) and are easily identified when you know the range of shades of both minerals, as well as vivianite's particular behaviors and characteristics.

Today it is impossible to know the precise relationship the Haida and Tlingit of the past had with colors, and specifically vivianite; however, research has provided more than enough information to be able to formulate a thesis about how and why specific colors were used.

Combining information from a diverse body of literature with scientific analysis, examination of hundreds of objects with the patterns of use and the basic characteristics and behaviors of vivianite, my research indicates multiple factors that may have contributed to the important roles this mineral and the color blue played in Haida and Tlingit cultures. In addition, the unusual environments in which vivianite forms, such as bones and other decomposing organic materials, and its unique behaviors, such as chromism, provide reasons for why vivianite became such an important pigment.

Interviews with Northwest Coast scholars, artists, elders, and knowledge keepers have added invaluable insights into the roles colors play and how materials are respected and valued and help provide evidence to support my thesis of why Haida and Tlingit artists chose to use vivianite over other pigments for certain purposes, While it is a simple hydrated iron phosphate mineral, vivianite has complex behaviors that include, among others, color alteration, or chromism (fig. 2). This and its unique growth habits would have made it desirable as a supernaturally potent choice of material for ritual, ceremonial, and protective objects.

Research and Methodology

Pigment stones, paint samples, substrates, and painted areas of objects were analyzed to determine the identity and composition of blue paint from various Northwest Coast Native artifacts and depositional sources for research and conservation purposes. The majority of analyses of the elemental compositions of pigment/paint samples has been done at Western Washington University using a Tescan Vega Scanning Electron Microscope equipped with an EDAX X-ray spectrometer. Pigment samples one centimeter in diameter were mounted on aluminum platforms with graphite tape and then coated with palladium. Elemental and mineralogic interpretations were determined in consultation with George Mustoe, a geochemist of the geology department of Western Washington University.

Testing with pXRF (handheld x-ray fluoroscopy) was done by iron oxide expert, Heidi Gustafson, and by staff at a number of museums in the United States, Canada, and England. XRF and scanning electron microscopy/energy dispersing x-ray (SEM/EDX) analysis has been conducted to identify pigments for this research and on

behalf of conservators and collectors, and museums such as the Seattle Art Museum and Burke Museum in Seattle, Washington, and the American Museum of Natural History in New York.

The simplicity of vivianite's elemental composition does not require technologies beyond XRF and SEM/EDX for identification. Although these methods of scientifically identifying vivianite have been sufficient thus far to this research, further in-depth study of vivianite's behaviors would be extremely beneficial in understanding all the factors causing chromism and how to prevent it.

Historical Perspective

In spite of a limitless array of modern colors, the basic Northwest Coast palette has consistently remained the same for thousands of years: black, red, blue, and green.

Today, within the spectrum of these four colors (fig. 3), the range of shades closely emulates those of traditional pigments. This speaks to how deeply embedded these four colors are in Haida and Tlingit cultures. In addition, while this color palette holds much information, of the four colors the blue of vivianite is inarguably the color that can give us more information about Northwest Coast cultures than can any of the other colors.

As remarked by William Fitzhugh and Aron Crowell, the art of the Northwest Coast is "the most stylistically complex art of any hunting and fishing peoples of the Americas."[4] Attaining the current level of sophistication, complexity, and cultural significance of Haida and Tlingit art took thousands of years of consistency and refinement. During this time color-use patterns became unified with the elements of the art form; discerning these color-use patterns and understanding color-making materials helps in extrapolating the significance of individual colors and the roles they play.

Humans utilize the resources available in whatever environment they find themselves including colored earths or pigments. It is safe to assume, that like humans elsewhere in the world, people new to the Northwest Coast soon located the materials for making paint.[5] The knowledge of how to source and use pigments would have been brought with them into the new landscape, and they would have adapted any new materials to previous practices and methods. Pigment residue consisting of red ochre and celadonite was identified on three grinding stones at Simon Fraser University.[6] These grinding stones were dated at about 4,000 years old by Dr. Roy Carlson, former director of the archeology department at Simon Fraser. These grinding stones give us a benchmark for early use of pigments by the Haida and Tlingit. The years between this 4,000-year mark to about the late 1600s (the date for the earliest known painted object) are not devoid of painted objects; this time span would have seen many objects being painted. We need to start testing archaeological artifacts for the presence of pigments that are no longer visible. Not only that, objects predating the pigment grinding stones also need to be analyzed for traces of pigments. Fortunately, in order to find painted objects that fill this gap, we can test ancient archaeological objects made of stone and wood for traces of pigments and begin filling this void in the history of color use on the Northwest Coast.

It is important for this research to determine the oldest painted artifacts. While we have not yet conducted that research, using the date of collection or acquisition as a benchmark quickly eliminates any blue pigments that were not yet available to Northwest Coast Native artists. This facilitates identification of regionally available vivianite from other blue pigments. Creating a timeline that synchronizes artifacts, dates when various pigments became available, and color use has been a useful tool and has helped in formulating the information in this paper and furthered color use and pigment research. To continue developing color-use patterns an ongoing, comprehensive survey of artifacts from as early as possible to contemporary is necessary.

Color in Form and Function

Color and Form

As with all things pertaining to Northwest Coast Native art, form and function must be discussed; in this study, color in relation to both form and function is analyzed. The form of every Northwest Coast object is predicated on its function, and even how colors are used follow this principle. Ingenious and highly cultivated, the Haida and Tlingit developed a richly complex and sophisticated art form that expresses social hierarchies and mores, lineages, history, spirituality, cosmology, and worldviews. The symmetry between color and form in Haida and Tlingit art integrally work together to reflect balance in sociocultural complexes, and to complement and enhance each other.

Many people conflate the black, red, blue and green of formline art with the meanings of colors according to those of other Native cultures. Colors do not have universal meanings, however, and thus the palette of the Northwest Coast must be evaluated and interpreted based on the specific system of color meanings of the Northwest Coast. The traditional four colors are a fundamental element of a closed system of representation that is understandable only to those educated or enculturated in its codified meanings.

Symmetry between color and form, and in many cases, function, in Haida and Tlingit art work together to reflect the balance required for the complex Northwest Coast sociocultural constructs. Color and form also complement and enhance each other as well as the compositional structure of formline art. This in turn lends itself well to the use of a narrow palette of colors by having three fields: primary, secondary and tertiary. Figures 1 and 12 are good examples of how the defining formlines, or primary fields, are black and the secondary fields are red. This is the most common layout for colors in Haida and Tlingit designs. The tertiary fields are left unpainted, or if painted, are either blue or green.

Within this system the color blue is transcendent; it represents something both utterly earthly and something supernatural. In painted Haida and Tlingit design blue does not just fill space, it communicates important information about the owner of the object and/or the type of object, and in many cases may well add a layer of supernatural power. On three-dimensional objects such as masks, helmets and house posts, blue creates expression, giving nuance and subtleties to features (fig. 4); the light plays

across the blue, creating shadows and highlights that animate faces and engage the viewer's imagination.

It is important to remember that all the artifacts we now view under electric lighting were created to take advantage of firelight; the settings in which they came alive were vastly different from the ones in which we now see them. In the light of a fire, color and light and shadow created movement and animated the forms and features of masks and rattles, house posts and other objects, engaging viewers on a contextual level. This context is critical in understanding the significance of color in relation to the form and content of Haida and Tlingit objects. Imagine shifting shadows cast by dancing flames, streamers of light flickering across the room, smoke drifting heavily. Listen to the murmurs of anticipation and anxiety rippling through those gathered; the stage is set for mystery, for evoking mystery and awe and surprise—a very different world from the one these now-silent objects inhabit today.

Northwest Coast artists well understood the art of theater necessary to engage and hold an audience rapt. Those artists knew how to create an interplay of color and chiaroscuro to bring these objects to life and capture the imaginations of the audience. Today we see these pieces in a sterile environment, with poor lighting, beside objects that have no particular relationship with each other, and all bereft of context and in many cases now, content. Unfortunately, unlike the original audiences, we are not able to engage intimately with these artifacts, to hear what they have to say, to experience them in the settings that gave them life and made them meaningful.

Color and Function

Among the Haida and Tlingit there exists a social hierarchy that correlates to a color hierarchy in which blue is of singular importance, being reserved for objects that denote protection, status, prestige, mystery, and liminality. The intrinsic value of the materials which make color are as relevant to function, and as deeply rooted as the value of the colors themselves. Vivianite, by its very nature, corresponds to specific functions, adding value (non-monetary value), bringing desirable characteristics and meaning to the artifacts on which it is used.

It is rare to find an object from the Northwest Coast that performs no function. For example, bentwood boxes and chests were household storage or cooking containers. Elaborately carved and painted chests were used for storing ceremonial regalia and other important possessions, and as mortuary boxes. Masks had specific functions; be it commemorating someone, assisting a shaman in healing, or representing legendary characters, each fulfilled a role. Totem poles were, and still are, reminders of clan heroes and ancestors and they speak of historical events. They are akin to the addresses we use today to identify our homes, but in a more socially oriented way, for they announce who the owner of the house is and something of his history or lineage to all viewers. Even jewelry identified the persons wearing it as having a particular status within their society. Every object had a purpose and the form of that object derived from that purpose. When objects were painted, the colors used contributed another layer of function relative to the form and purpose.

The hat in figure 5 is an example that signifies the lineage and status, and indicates to which clan the owner of the hat belongs. The addition of blue paint behaves much like the use of ultramarine blue did in Medieval European paintings: it shows the world the owner is wealthy enough (materialistically and socially rather than financially) and of high enough status to afford vivianite paint, both as ornamentation and as numinous protection.

On certain objects the use of a three-color system congruent with the three-field system of formline is integral. Black and red help orient our eye to the features of the design and signify which elements are the foundations of the design and which are there to tell the story. While formline can be rendered in just black and red, and even in a single color, by doing so, part of the meaning of the design might be compromised. Each design has an overt meaning contained within the black and red in the primary and secondary fields. A subtext is added when tertiary fields are painted blue. To understand this subtext, we must examine the roles blue plays in Haida and Tlingit cultures.

When we look at the defining colors for northern formline, black and red, it is clear these two colors contain information held within the design. The blue in tertiary fields communicates some of that information; it helps designate an object as one representational of wealth and status, having some spiritual element, and/or being of other particular significance. Although the overt functions are obvious with many objects, the less obvious purposes were expressed through carved designs and color.

The intrinsic value of vivianite as a material adds another layer of cachet to the value and esteem of an object. As material, the conditions in which vivianite forms and its subsequent behaviors make it a material that in its own right has value, for instance, when compared to the materials that make black. This is not to say black does not have significance, but rather to stress that according to this research, blue plays a very distinct role in Haida and Tlingit cultures and art while black is used in a more generic way. In this, blue, and vivianite specifically, go beyond the formline foundation of black and red, and beyond the function of the object to communicate what the owner considers important to express.

Since color was never used randomly, and because color fulfilled many functions, we have to examine color use among the Haida and Tlingit for how it is used rather than how it is perceived, that is, for the artist's and owner's intent instead of how the viewer interprets the colors used, and for its purpose beyond ornamentation. To begin understanding the functions of colors (as opposed to the meanings of colors) we need to extrapolate from Northwest Coast objects the consistent patterns and logic of color use through occurrence, and frequency of occurrence, on specific types of objects. We need to evaluate how color is distributed and perform a thorough analysis of placement and purpose, especially of the color blue. The relationship between color and form, and color and function among Northwest Coast people is one that must be investigated as an entire system.

Chroma, Composition, and Morphology

Chroma

On Haida and Tlingit artifacts the presence of vivianite can be determined to a high degree of certainty through visual examination if you know some of the characteristics that distinguish it from other pigments. The blue of vivianite is distinctive in comparison with other blue pigments and is easily spotted, especially in side-by-side comparison to other blues. However, the wide range of shades of blue, blue-grays, and blue-greens of vivianite (fig. 6) can lead to misidentification by those who do not have much experience identifying vivianite.

Vivianite tends to have a gray undertone and is often described as "earthy" and "soft," "muted," or "dull." The tinting strength of vivianite is low, so unless applied in heavy or multiple coats, it is rarely consistently opaque, allowing the substrate to be visible. When visually identifying vivianite, it is not as reflective as other pigments. Unlike "brighter" ultramarine blue and darker, more saturated Prussian blue, vivianite is not reflective, but rather absorbs light, even with a lipid binder. When vivianite has altered color and darkened, it often increases in green tones, eventually becoming a dark olive green-brown, and then black. Once this occurs in formline art, there can be no doubt it is vivianite. Recognizing the characteristics of vivianite, its unique coloration, how it looks when applied with water versus fat-based binders, knowing the range of shades and what the finish should look like, all contribute to being able to discern the presence of vivianite as opposed to other pigments. Knowing the relative age of the piece, or at least when it became part of a collection, is also helpful in identifying the pigment.

Composition and Morphology

Unlike minerals that were created early in Earth's formation and are finite, vivianite is an authigenic mineral, one which is found where it forms, and is constantly forming as amorphous earth and clay, and as stone and crystals. The focus of this paper is the amorphous earthy, clay form as this is what is commonly found on the Northwest Coast. Vivianite only requires three conditions for formation: the presence of iron, decomposing organic matter, and an anaerobic environment.[7] On the Northwest Coast vivianite is frequently found beneath and intermingled in peat beds and as clay deposits. It also forms in fossilized vertebrate remains and calciferous materials like shells and teeth, as in figure 7, bone, ivory, and wood.[8]

It is also found growing in and around burial sites, on both human and animal remains, and on all kinds of skin (fig. 8), including tanned hides.[9]

One of the best-known examples of vivianite formation on animal remains is Blue Babe, a 36,000-year-old, mummified steppe bison now residing in the University of Alaska's collection.[10] Vivianite also forms in areas where there is human or animal waste and blood, such as leaking septic tanks and places like stockyards where blood and animal waste is abundant.

Today, vivianite commonly forms in the end-stage pipes of wastewater treatment facilities.[11] Analysis shows a purified form of waste treatment vivianite that rivals natural vivianite for color and pigmentation qualities. Vivianite created from waste matter (fig. 9) is finding applications in technology, agriculture, toxic waste remediation, and a host of other fields, in addition to its application as a stunning blue pigment. Synthetic vivianite, which is created from a specific process and mix of chemicals, is being used in a wide variety of applications, including medicine.

Chromism

Throughout the life of vivianite it changes color (chromism) from neutral or white when first exposed to light, then to blue, and on to olive green and brown before the very end of its cycle, when it the chemical formula changes and it turns black.[12]

Figure 9 is a piece of vivianite from a waste-water treatment facility in Holland. Upon exposure to light, the vivianite turned the blue in the image. However, in a photograph taken one year later, it is clear significant chromism has occurred, turning the piece almost black (fig. 10), even though it has only been exposed to low electric light. In a series of timed tests in which fresh, white, amorphous vivianite was exposed to sunlight, vivianite was documented and photographed turning blue. To determine rapidity of chromism, fresh vivianite was exposed to average sunlight and to the light of a gray, rainy day. In sunlight, vivianite began turning blue and reached a deep, well-saturated blue (fig. 11) within an hour. The cloudy, gray day showed color changes slowed to four to five hours, with some samples taking as long as six to eight hours to turn deep blue.

Determining whether the mechanism by which vivianite changes color is triggered by light or oxidation (exposure to oxygen) was one of the most important questions in relation to the appropriate storage and treatment of artifacts with vivianite paint. This was tested by placing freshly gathered, white vivianite in containers of water, some of which were clear and some lightfast. The samples placed in lightfast containers remained white. All samples submerged in water in clear containers, i.e., those in which light could reach the sample, began changing color immediately and achieved a strong blue as rapidly as did those simply exposed to the sun. Because the amount of oxygen in water is so minimal, these experiments indicate chromism is initially induced photochemically.

In other experiments, vivianite was observed and timed changing from white to blue in incandescent and fluorescent lighting. In these tests chromism occurred less rapidly than in sunlight, and varied in degree and length of time. All of these experiments need to be repeated in a more controlled environment with the appropriate instrumentation for measuring color change, degree of light, and similar variables. However, these rudimentary findings are indicative of light being the primary and long-term mechanism for chromism in vivianite.

The darkening of vivianite on Northwest Coast objects helps to immediately identify the pigment on Northwest Coast objects. The tertiary fields of the chest in figure 13 show vivianite that has darkened. In the image the paint in the tertiary fields

looks like a soft black, has a different texture, and is not as dark or reflective as the formline, which is painted black. This reflectivity and different texture are notable when determining darkened vivianite from regular black paint. There are many objects on which the tertiary fields have paint that appears to be black or very dark brown. Since formline design has discrete fields of color that are prescribed by tradition, it is unlikely artists used black paint in tertiary fields, especially when black is already present in another field. Another clue indicating the presence of vivianite is that black and red pigments were often mixed with a lipid binder, which causes these paints to have a reflective sheen; on those same pieces, vivianite was usually applied with just water, creating a matte, dull finish.

There are many factors which may contribute to vivianite's chromism: the type of binder, exposure to light, preservation treatments, and other factors now unknown could all be reasons for the color change. Red and yellow cedar, the typical species of woods used for bentwood boxes and chests, contain natural oils that may be part of the cause of vivianite changing color on some objects. In the process of restoring and repairing Northwest Coast objects I have frequently observed the alteration of paint colors, even with modern acrylic paints, due to the natural wood oils. On some objects the color alteration of vivianite may be attributed to these oils.

Chromism in Process

Both Haida and Tlingit cultures produced a wealth of objects that have blue paint in the tertiary fields but on bentwood boxes and chests it is very easy to spot vivianite paint, both as the natural color and when it has darkened. It is not uncommon to find areas of chests, and even entire chests, on which vivianite paint has changed color; this has been a useful characteristic in identifying vivianite. A twenty-five-year study of bentwood chests painted with blue includes three chests at the University of British Columbia's Museum of Anthropology attributed to Albert Edward Edenshaw.

The blue paint on the chest in figure 12 can clearly be seen in the tertiary fields; however, during the study period the vivianite paint has darkened measurably (photographs of both figs. 12 and 13 are more than ten years old).

The tertiary fields on the chest in figure 13 look as if they were painted with a soft dark brown or black paint. The only blue that is visible, in person, is a square at the bottom right corner on the front of the chest.

In-depth study of objects made by Albert Edward Edenshaw indicates he did not use lipid binders with vivianite; he used vivianite frequently and would have been familiar with vivianite darkening when applied with a lipid binder. It is likely that this chest was treated post hoc with waxes or oils in an effort to preserve the wood. Unfortunately, this is disastrous for maintaining the true color of vivianite.

The three Edenshaw chests are on exhibit with many other artifacts in a large glass room that allows constant exposure to ultraviolet (UV) light. It is well known that UV light is directly responsible for the overall deterioration of paint and wood. The persistent exposure to UV light is a major concern in the long-term preservation of these chests, as well as all the other objects in this space. The color changes to vivianite

Figure 1. *Yeil X'eenh (Raven Screen), Tlingit, late-eighteenth century. Attributed to Naakustaa. Photograph by Paul Macapia courtesy of Seattle Art Museum #79.98.*

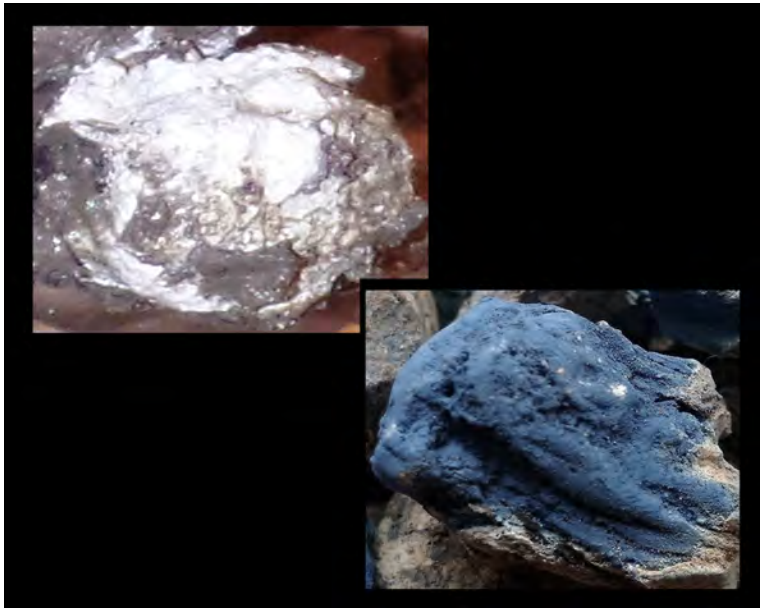

Figure 2. A: *Fresh vivianite before washing;* B: *Vivianite after two hours of moderate sunlight. Author's collection.*

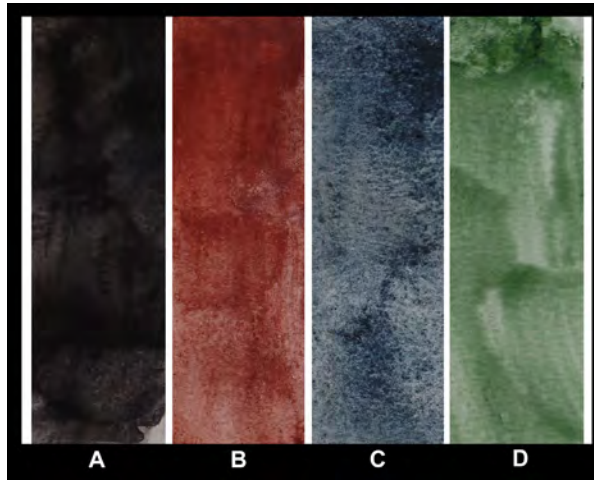

Figure 3. *Traditional pigments.* A: *Charcoal black;* B: *Red ochre;* C: *Vivianite;* D: *Celadonite. Author's collection.*

Figure 4. *Detail of Dukt'Tootl Gass housepost, Whale House, Klukwan, Alaska, ca. 1830; attributed to Kadjisdu.'axch (Tlingit, Gaanaxteidi Clan). Photograph by Barry Herem.*

Figure 5. *Tlingit woven clan hat with cover. Image courtesy of the National Museum of the American Indian, #98087.*

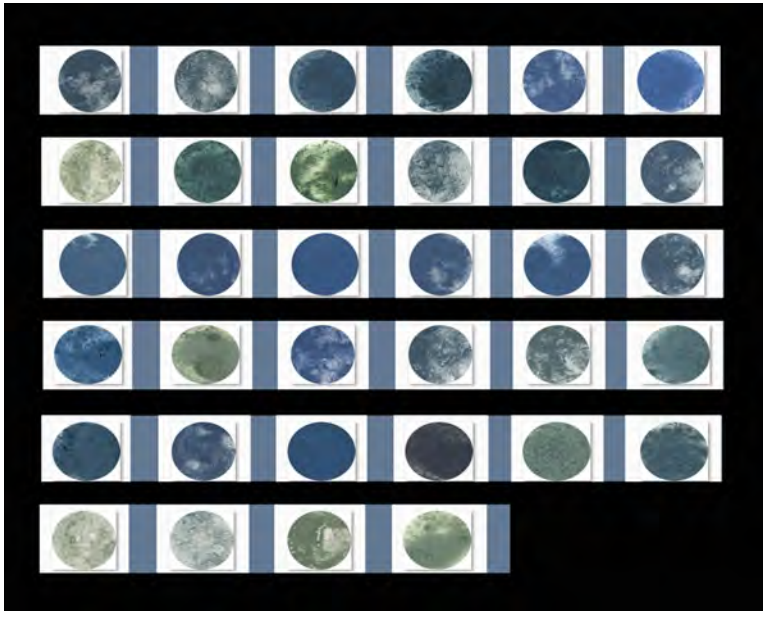

Figure 6. *Range of shades of vivianite. Author's collection.*

Figure 7. A: *Pleistocene-era cedar from vivianite deposit. Author's collection.* B: *Vivianite in mammoth ivory. Photograph by Iain Clarkson Image courtesy of Fossil Realm.*

Figure 8. *Tlingit war tunic with natural vivianite formation. Image courtesy of Fenimore Art Museum, #T0746.*

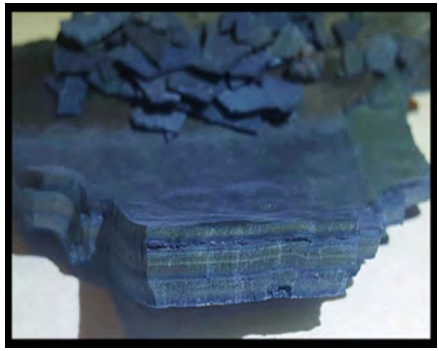

Figure 9. *Vivianite scaling from wastewater treatment pipes. Author's collection.*

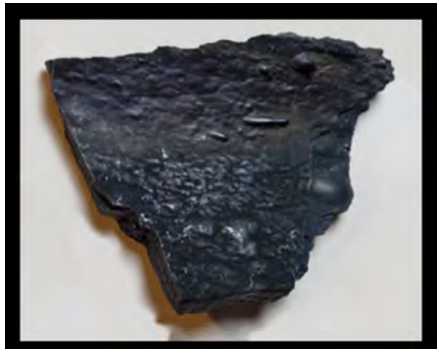

Figure 10. *The vivianite pictured in figure 9 after a one year exposure to low incandescent light only. Author's collection.*

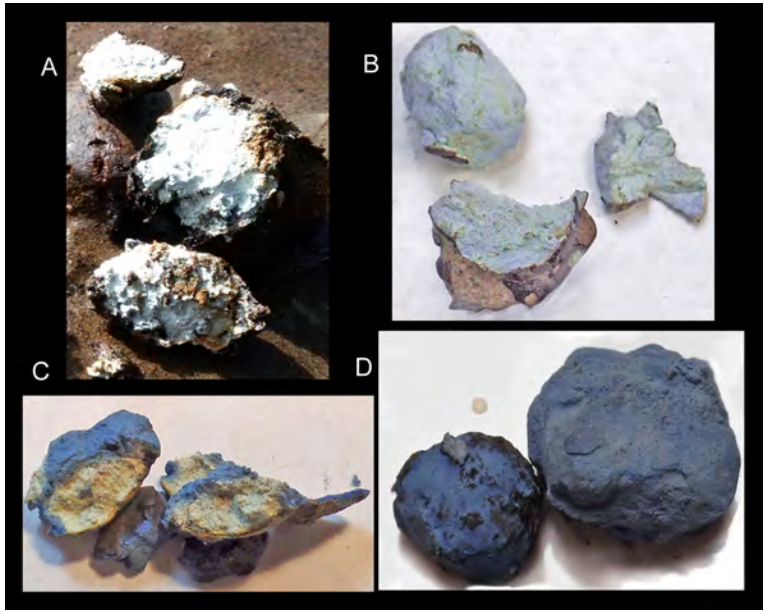

Figure 11. A: *Vivianite in situ;* B: *after a fifteen-minute exposure to light;* C: *exterior changed but interior still white;* D: *after a one-hour exposure to light. Author's collection.*

Figure 12. *Bentwood chest with vivianite. Attributed to Albert Edward Edenshaw. Image courtesy of University of British Columbia, Museum of Anthropology,* #A2443.

Figure 13. *Bentwood chest with darkened vivianite. Attributed to Albert Edward Edenshaw. Image courtesy of University of British Columbia, Museum of Anthropology, #A9416.*

Figure 14. *Tlingit Shaman's Oyster Catcher Rattle with vivianite. Image courtesy of the American Museum of Natural History, Division of Anthropology, #16.1/1016.*

Figure 15. A: *Shaman's mask with vivianite paint. The extended tongue and rolled-up eyes are indicative of a shamanic trance. Image courtesy of Fenimore Art Museum;* B: *Portrait mask. Image courtesy of University of Oregon, #2-18172.*

Figure 16. *Yu'pik mask with vivianite paint. Photograph by John Bigelow Taylor courtesy of Donald Ellis Gallery.*

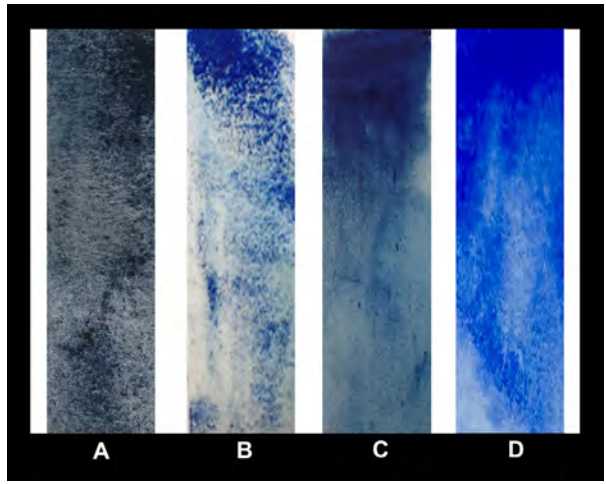

Figure 17. A: *Vivianite;* B: *Azurite;* C: *Prussian blue;* D: *Laundry bluing/synthetic ultramarine blue. Author's collection.*

Figure 18. *Haida frontlet with vivianite. Vivianite paint has no binder. Image courtesy of Burke Museum, Seattle, #1-1448.*

paint will eventually cause a significant loss of information and reference material (including the objects themselves) for current and future generations.

Transformation and Liminality

The ability of humans and animals to metamorphose one into the other and even into natural objects and phenomena is fundamental to all Northwest Coast cosmologies and is a constant theme in the histories of all Northwest Coast cultures. Since this kind of mutability is so important, it follows that materials with transformational and liminal properties, like vivianite, would be very desirable to artists and shamans. Even more significantly, vivianite transforms from white to blue, a color Haida shamans associate with portals to other realms.[13] This all sets the stage for the association of blue with the sacred, spiritual, and supernatural.

It is important to understand that, like transformation, liminality is a key element in Haida and Tlingit cosmology. The Haida believed they lived in a liminal zone, a space "between sea and forest, earth and sky, and animals and gods."[14] They also believed blue is a liminal color, one which can be used as a portal to other planes.[15] Vivianite is always in a state of liminality, a state in which it is in between, or on the edge of becoming something different or new. In addition, the mineral crosses boundaries of color and state, as well as connects different planes. The formation of intense blue vivianite out of waste—whether it be human/animal waste, decomposing organic matter or human/animal bones and tissue—firmly places vivianite as a transformational and liminal material.[16]

Whether in nature or on an object, Northwest Coast people would have been familiar with vivianite's mysterious chromism. Of the four traditional colors, black, red, blue and green, the blue of vivianite is the only color with transformational and liminal qualities. Vivianite's ability to transform from white to blue and eventually to black would have been a compelling characteristic when using it to paint objects for ritual and protection. The unusual types of environments and conditions in which it forms, such as in bone, could make it even more spiritually potent.

To understand the significance to Northwest Coast people of the correlation between bones and vivianite formation, we need to know that Haida and Tlingit people "believed bones were the essence of life" and that they were symbols of death and regeneration.[17] Vivianite frequently forms in bones which in Haida and Tlingit cosmologies would associate it with beliefs surrounding death and rebirth increasing its supernatural potency. Another facet of vivianite's potential for providing physical and spiritual protection stems from its genesis in death and decomposition, which would have increased its efficacy as a supernatural protection and spiritual conduit.

If we consider how blue contains and transcends earthly planes, that it seems to encapsulate the world and connects earth with sea and sky, we see how vivianite starts becoming a supernatural material and concept. Then, consider the concept that blue crosses boundaries from the secular realm into the supernatural world of spirits, death, and the afterlife, and provides a pathway into the world of spirits and spirit helpers that adds another facet to vivianite's power. When we include the places and ways in

which vivianite forms, this mineral's significance to Haida and Tlingit shamans, leaders, and warriors becomes quite clear. Both shamans and warriors of the Northwest Coast spent their lives in a liminal zone, balancing on the border of life and death; they were both of, and separate from, the rest of their community. Vivianite's behaviors and characteristics would have made it a powerful material for ensuring the safety and well-being of those participating in ritual, transformational, and liminal activities.

Types of Objects Painted Blue

The desire to possess objects and materials imbued with spiritual powers of protection would have made vivianite a desirable material for the safety and well-being of shamans and warriors. Just as vivianite could enhance the power of the individual, it also could increase the wearer's supernatural protection. Rarely seen on objects of common use, vivianite is prominent on shaman's regalia and accoutrements, on the gear of warriors and on the ceremonial objects, and on implements that indicate status. In all its roles, vivianite provides functions that are different from those of black, red, and green pigments that are congruent with the form and function of the object.

The relationship between Haida and Tlingit shamans and nobility was a complementary one; each held positions of responsibility for the welfare of their communities.[18] Leaders worked to keep balance within the village and between villages while shamans strove to keep balance between the village and external forces. Shamans, many of whom were from high status lineages, and the leaders of a village both required implements that represented and signified their status and power and assisted, spiritually, with their tasks. While their regalia and paraphernalia already conveyed status and power through the type of object and carved designs, adding vivianite paint could incorporate another layer of potency.

The nobility had only to express their position to the temporal community while shamans required the ability to impress their status, power, and authority in both the temporal and spirit worlds. It was necessary for shamans to demonstrate their worthiness and power to the spirits while, at the same time, they needed to impress their temporal world with their authority and power to interact with spirits. Like objects used by nobility, the rich carvings of a shaman's paraphernalia (fig. 14) were an indicator of wealth and status; adding blue to them enhanced this and contributed spiritual influence.

The implements shamans used were inherently imbued with spiritual energy; the addition of carved representation of their spirit helpers added another layer of potency with vivianite augmenting those supernatural powers.

The origins and characteristics of vivianite, as well as its color, lend this pigment well to the needs of a shaman, both in his secular life and in his supernatural work. During trances shamans traveled across dimensions, leaving their untenanted bodies vulnerable to both spiritual and physical attack. In both worlds shamans battled death and evil spirits, facing dangers that required powerful forces for protecting themselves and assisting in their work; it makes sense that vivianite paint contributed additional supernatural power on items already imbued with supernatural forces.

During healings and other rituals involving supernatural intervention, masks were used by shamans; certain characteristics help to determine whether a mask belonged to a shaman or to someone else. For example, protruding tongues indicate the transfer of breath or spirit, as well as depict trance states or impending death; bulging eyes and wrinkles indicate great age. Macabre countenances are often a feature of a shaman's mask that was used for ritual and healing, but the most common element of these masks across the gamut is blue paint. In fact, blue usually covers more area than any of the other colors. In a survey of three hundred masks of all types, the prevalence of blue in tertiary fields was 75 percent higher on masks attributed to shamans than the non-shamanic pieces. This would seem to be compelling evidence that vivianite and blue were regarded as having some relationship with supernatural powers.

Frequently, the cheeks, foreheads, and chins are painted blue, while orienting features such as eyebrows, nostrils, eyes and lips are painted red and black. It is apparent on many shamans' masks that blue paint was used to theatrical effect: imagine the mask on the left in figure 15 looming over your sickbed in the fitful firelight! That visage alone could frighten you into wellness again—or hasten your death.

Both shamans and warriors of the Northwest Coast spent their lives in a liminal zone, balancing on the border of life and death. It makes sense that some of the function of the blue paint on war helmets and tunics was to provide an element of supernatural protection to the warriors. Even when not engaging in warfare, warriors spent their lives preparing for war, both physically and spiritually, placing them in a perpetual liminal state.

Creating lifelike qualities such as a sense of vitality and movement was so important to these cultures that the stories and epic poetry are filled with descriptions of artworks that came to life, objects that moved without human assistance, provided food, and even some that killed.[19] Skillfully used blue paint creates the illusion of life and movement and enhances the experience of using and living with these artworks. In addition, the highly refined art of theater among the Haida and Tlingit appears in the painted blue designs of war helmets. The artists well understood and utilized the context in which these objects would be seen to best effect. Blue being a color associated with death, painting the faces on the helmets blue would strike awe and fear in the enemy; imagine seeing an army of what appear to be dead men rushing at you, brandishing war clubs and spears, ululating and roaring at the top of their lungs. These ghastly visages must have stricken the enemy with terror, perhaps creating a psychological advantage.

Ancient Knowledge, Ancient Practice

As with the knowledge of other mineral pigments such as red ochre and celadonite, the knowledge of vivianite has been carried forward from the earliest days of humans on earth. When we stop to consider humans were actively processing red ochre as a pigment more than 250,000 years ago, perspective is put on the probability that vivianite was discovered and adapted into use early in human history.[20] In fact, vivianite has been discovered on a number of Western masterworks, which European

conservators (at least so far) have dated to as early as the 800s. Once Northwest Coast archaeological artifacts begin to be analyzed for traces of pigments, it is likely we will find traces of vivianite as well as the other pigments typical of Northwest Coast art.

The knowledge of how and where to find pigments was handed down through the generations as part of an artist's training and through oral histories. Certainly, among the people of the Northwest Coast the color blue is mentioned in stories, poems, and songs.[21] As cultures intimately acquainted with their environments, the Haida and Tlingit had plenty of opportunity to discover deposits of vivianite. Northwest Coast Natives are not the only people indigenous to North America who have used vivianite. According to a 2007 article in the *Journal of Middle Atlantic Archaeology*, the Natives of the Eastern Atlantic Coast used vivianite for body painting.[22] However, no literature references any other North American cultural groups using vivianite as a pigment for objects other than the Northwest Coast and the Yu'piks.[23]

Among the Yu'piks of western Alaska the use of vivianite has been documented by Dorothy Jean Ray. The knowledge and use of vivianite (fig. 16) has remained unbroken throughout Yu'pik history; my research reveals the same deposits used a thousand years ago are in use today. Through an intact oral history, the use of vivianite for special masks has remained constant in Yu'pik culture. Although the Yu'pik have a long history of vivianite use, they are not included in this study because they are not part of the Northwest Coast cultural complex.

Blue Pigments and Trade Colors

Until the mid-late 1700s azurite, a copper carbonate, was the only, and rare, competitor for vivianite; there simply were no other blue pigments available on the Northwest Coast. The references in Northwest Coast literature to copper oxides like azurite being the mineral used to make blue paint are incorrect. None of the samples mentioned were properly analyzed, and the subsequent literature references are a reiteration of early ethnographic statements, with no actual verification.

Until Prussian blue became available for artist use in 1704, my research indicates that azurite was the only pigment other than vivianite available to Northwest Coast artists. When Prussian blue pigment arrived on the Northwest Coast, it was adopted into the Northwest Coast palette but it rarely replaced vivianite and was not often used for the same purposes. Prussian blue is a very distinct color and is quickly identified by visual examination; there is little room for error when compared to vivianite.

Other blues followed Prussian blue (fig. 17): a synthetic Ultramarine blue arrived in the form of laundry bluing cakes, cobalt blue showed up in the mid-1800s, cerulean blue followed in the late 1800s. Like Prussian blue, they were all incorporated into the palette, but still did not eliminate vivianite or find use on certain objects. Ironically, in spite of the accessibility of new blue pigments over the years, a large number of artifacts post-date their availability, and even after the advent of premixed paint, my study of bentwood boxes and chests shows artists like Charles Edenshaw were still painting with vivianite into the 1900s. Perhaps the new trade colors were not acceptable for the types of objects requiring blue paint or the functions vivianite fulfilled. Vivianite's

unique characteristics, none of which can be found in those new pigments/paints, were still vital to proper ritual functionality.

Wild Blue

It is human nature when finding a colorful stone or earth to pick it up and see if it will make color. This is something done by children and adults alike; it is part of how we explore our world, but it also gratifies our need to leave a mark and to create. Finding vivianite in the landscape would not have been difficult for Northwest Coast people; the intimacy they had with their environment is one that is only imaginable today.

According to noted Northwest Coast scholar and artist Bill Holm, in the late 1800s and early 1900s the interiors of seagoing canoes were painted blue.[24] However, vivianite is supposed to be a rare mineral, according to the scientific and mineralogical literature, with the crystal and stone forms found less often than the earthy form occurring in the Pacific Northwest. How, then, could Northwest Coast people afford to lavishly paint the interiors of their canoes blue? When I followed up this question with a thorough study of geologic and soil maps and interviews with geologists, it quickly became clear that vivianite is an abundant resource that forms quite easily in common environments and it can be found all over the Northwest Coast as well as the world. In the past it was quite accessible all over the Northwest Coast. There are hundreds of these deposits of varying sizes from southeast Alaska to Oregon. Soil maps indicate many deposits in Oregon, Washington, mainland British Columbia, Vancouver Island, and southeast Alaska and make it likely that there was enough vivianite for each cultural group or even village to have their own deposit within easy access.

Because vivianite is readily available, it does not make sense that any of the people of the Northwest Coast would have had to trade for it. In a recent study of the procurement of red ochre, it was found that this material was sourced from sites closest to the place of residence and/or use.[25] This is likely to be true of other pigments as well. Like with all other resources, pigment deposits would have been "owned" by a family or clan and they would have had direct relationships with the places at which pigments were locally available. Landscapes were often imbued with some kind of importance which made, in turn, the pigments particularly special. Sourcing materials from distant regions or through trade would decrease the significance of those materials and reduce the likelihood for use on ceremonial or spiritual objects.

Making Paint

The best vivianite pigment is made from amorphous clayish material that is usually free of contamination from other materials. Once cleaned of any debris it tends to be a high quality, very pure pigment of a distinctive, intense blue that cannot be replicated by the mixture of any two or more other colors. Making paint with vivianite is simple; grind, mix with water or binder, apply. But first, it needs to be understood that grinding vivianite exposes a larger amount of surface area to light and oxygen which accelerates chromism. And mixing with certain types of binders, particularly lipid-based ones, can

turn vivianite very dark and even black; this would have been common knowledge, at least among Northwest Coast artists who would have accommodated for this.

It was not common for Haida and Tlingit artists to mix two or more colors together, or to add fillers. According to my research and the Canadian Conservation Institute, paints were "lean, pure, unadulterated and unfilled."[26] Nor was it ordinarily necessary to manipulate the pigments beyond cleaning and grinding them. There are a few references to yellow ochres being roasted to obtain red, but it is doubtful this was common practice as red ochre, and in some locations, cinnabar, were available. Roasting vivianite would have been pointless because the hydrogen molecules in vivianite start to break down at 70 degrees Celsius, which causes the color to change to black.[27]

Binders

The binder most commonly referred to in Northwest Coast literature is salmon eggs. My research, however, indicates fish eggs were not used as frequently as has been thought, although there is some small evidence that fish eggs may have been used for specific objects. As a valuable food source, fish eggs were not likely to be squandered on paint as much as the literature claims, especially since there were a variety of other binding materials which were available year round, easier to work with, and less precious. The fat from animals like bear and oil from seals and fish were more abundant than fish eggs and were often used as binders. Lipid-based paint is distinct from non-lipid; when mixed with lipids, all pigments darken (vivianite more so than other pigments) and the paint is thicker. When paint made with a lipid binder dries, the result is a denser, more opaque, almost plastic film with a reflective, satiny finish.

The key to recognizing the different types of binders is to know the effects each one has on vivianite. Applying vivianite with a fish-egg emulsion or animal fats causes the color to darken to a very deep shade of blue-black that is distinguishable from other blues like Prussian and ultramarine blue even by an inexperienced eye. Vivianite paint made with just water is even more distinguishable from other blues like Prussian and ultramarine blue that were typically applied with lipid binders. When water is used as a vehicle, the resulting paint is powdery like gouache, somewhat velvety and very matte with no reflectivity. The color and tone remain true to the original pigment color. These characteristics make it quite easy to distinguish between the two main types of binders, non-lipid and lipid. It is common to find vivianite paint applied with water on objects on which the other pigments were applied with a lipid binder.

The flat, gouache finish of mask B in figure 15 tells us vivianite was applied with water. Since the darkened areas on the cheeks are uniform and not areas that would normally be handled, it is likely the artist darkened these areas deliberately; he probably just rubbed a little grease over them. The majority of masks examined in this study indicate vivianite was far more often applied with just water than with binders; it is rare to find a mask on which a lipid binder was used. From the enormous number of artifacts on which vivianite has been applied without a binder, it is clear Haida and Tlingit artists preferred vivianite in its natural state.

Experiments with other binders included fowl eggs, hide and fish glue, blood, and resins and gums, yielding varied results. When mixed with the yolk of fowl eggs, vivianite turns a distinct, unappealing green. With hide glue, it darkens slightly and acquires a slightly reflective finish. Blood darkens vivianite to black, while resins from conifers darkened it and created a consistency difficult to manage. With similar results to water, adding gums such as birch and cherry added only slight reflectivity and tended to flake off when dry.

These are difficult types of paint to manage: paint made with fat and hide glue needs to be kept warm enough to allow the paint to flow, for example. However, when the samples are mixed with animal fat they produce a paint that flows nicely when liquid and when cool they yield a paste that is more easily applied by hand than brush; this works especially well when painting large areas such as cheeks and foreheads with one's fingers. Samples mixed with blood darken vivianite to black and give a slick, highly reflective finish to the paint film; however, blood rapidly coagulates which makes using it as a binder a race with time.

The Haida frontlet in figure 18 is a good example of what vivianite looks like when applied with just water: a velvety, matte finish with individual pigment grains visible, no reflectivity, and no film. The inset detail reveals a little light reflection on both red and black paint, indicating that a lipid-based binder was used.

We can learn many things from the study of pigments and color use on the Northwest Coast including the frequency of use and handling of objects. A study of clan hats has helped in understanding patterns of use: many wood clan hats were painted with vivianite and water which makes the surface vulnerable to the oils on skin, leaving fingerprints in areas that were handled. Clearly visible fingerprints tell us how many times some of these hats were worn and how carefully they were handled. For instance, on carved wood clan hats fingerprints tend to be grouped in the same spot and same direction and overlapping on both sides of the hat, indicating that the person wearing it lifted it onto his head. While this may seem a minor detail, the accumulation of minor details often illuminates behaviors, practices, and beliefs and provides evidence in support of my theses.

Application

While much can be learned from technical testing of various kinds, one of the best ways of learning about paint materials, tools, and techniques is by careful visual examination. Examining artifacts visually allows us to see the texture of paint, including possible evidence of a binder, brush strokes, and to see how finely the pigment was ground. My experiments with various traditional tools used to apply paint demonstrate that in larger areas like cheeks, foreheads, and chins, the artist has more better control when paint is rubbed into the substrate rather than brushed on. This allows the artist to control thickness, opacity, and translucence which all contribute to creating shading effects. The Haida and Tlingit methods of shading when they painted differ from those typically used in western art: color and varying degrees of transparency and opacity created shadows and highlights. This helped to animate the object, but is

not easy to accomplish with traditional paint unless applied with fingers. Sometimes secondary and tertiary fields are hatched or cross-hatched to provide visual interest and mimic shading.

Art and Technology

Apart from this research, there has been only one other study of Northwest Coast pigment materials, *CCI Native Materials Project* (1990).[28] This study was conducted by the Canadian Conservation Institute (CCI) and was narrow in scope, having tested only 583 objects from across Northwest Coast cultures. However, there is no documentation relevant to Tlingit artifacts and pigments. Of those objects tested, the oldest was from 1850, while most were post–1878, relatively late in the history of paint on the Northwest Coast. There were 130 Haida objects in this study, of which twenty-one were tested for blue pigments. A total of twenty-six Tlingit objects were tested for other pigments, but there is no data recorded for blue pigments in the final report. And while there were 583 objects from all over the Northwest Coast, only fifty-seven were tested for blue pigments, and of those, more than half came back unidentified. All together, this study was far from representative of the cultural groups of the Northwest Coast, and was certainly not definitive.

As a simple mineral compound, vivianite does not require technologies beyond SEM/EDX or XRF to identify it on Northwest Coast artifacts, in contrast to paintings with a wider variety of pigments, binders, and sealants. The advantage of analyzing materials at an elemental level is the ability to use atomic weights as well as trace and secondary elements comparatively to match samples to deposits and other artifacts. Having scientific evidence behind the materials is also adding validity to Northwest Coast Native art history in the framework of world art history. It is helping to confirm Northwest Coast Native art as "important to the heritage of mankind."[29]

By using SEM/EDX, XRF analysis and other technologies now available, the incontrovertible identification of materials such as vivianite is possible. We can see at the atomic level what elements are present in a sample and by matching trace elements and atomic weights identify sibling pieces and match samples to specific deposits. This offers us the possibility of determining more closely the origin of artifacts that do not have a clear provenance. Identifying vivianite on artifacts and matching those samples back to deposits may also assist us in ascribing authorship of particular works of art, if not to a specific individual, at least to a location and cultural group. It can help us build a better picture of the context in which the piece originated, where it may have traveled in its life, and the storage and conservation treatments it has undergone.

Implications for Further Research

The information that can be obtained from studying pigments, paint, and other materials associated with painting contributes to the overall documentation of an artifact. It can help us determine authorship, provenance, date of manufacture, and many other important elements of an artifact's life.[30] By studying pigments we gain new insights into the complex critical thinking and technical skills of individual artists, as

well as the cultures in which they lived. In addition, we open new paths of investigation and understanding of the relationship Northwest Coast people had with their environment, how they perceived their world, and how they put their cosmological beliefs into practice.

The insights gained with this research into the intricacies of Haida and Tlingit cultures and their relationships with all of creation are miniscule compared to what is yet to be revealed. One of the objectives of this paper is to inspire others to pick up the diverse threads touched upon and carry the research forward, seeking the knowledge inherent in the study of pigments, paint technology, and color use on the Northwest Coast. By studying pigments and paint technology we are given insights into the complex critical thinking and technical knowledge of the artists and the cultures in which they lived, but also, we become privy to their wealth of environmental, social and cosmological knowledge and practices. By studying individual pigments we have the opportunity to learn more about how early people acquired and used their resources, and potentially learn why they chose certain pigments for specific functions.

However, it is crucial we undertake a comprehensive study to determine all the factors involved in the formation, composition, morphology, characteristics, and mechanisms by which vivianite alters. There also needs to be full-scale, multidisciplinary research conducted into the traditional pigments, binders, tools, and techniques of Northwest Coast Native people for making and using paint. Even color use among Northwest Coast Native cultures has never been addressed beyond brief mentions in discussions of formline design, yet it is critical to better understanding the people and their artifacts. My research is only the first page in a book that is yet to be written.

Furthermore, every answered question about vivianite generates more questions that are beyond the scope of this research. Although isolated studies relevant to its specific characteristics are scattered across the scientific literature, no scholar or researcher has yet attempted a full-scale study of vivianite as a pigment. And the study of color use and paint technology on the Northwest Coast has only barely begun. In-depth color use research is necessary for us to understand more fully vivianite's behaviors and its, as well as all the other pigments, relationship to Northwest Coast Native lifeways and cosmology. The biggest question left unanswered is how to stop vivianite from changing color on these objects? Why the paint has darkened on hundreds of objects, but not on many others, needs further study. The rapidity with which chromism occurs varies and the full cycle is not yet fully understood; there needs to be in-depth study to fully explain the processes and mechanisms by which vivianite changes color and how to stop it. It is not enough to know that vivianite changes color; now that we know this occurs, it is the responsibility of current generations to pursue methods of preventing chromism and to make every effort to preserve these artifacts intact for future generations.

While we can see blue paint on thousands of artifacts already residing in collections, when did the use of vivianite begin and where are those earlier pieces? It is likely that once we begin looking much more closely at artifacts from archaeological digs, as well as those objects already in museum collections, with the intention of determining

age and all materials, we will begin to answer these questions. Understanding the composition and morphologies of materials can better help us conserve the valuable and informative artifacts we hold in our museums and private collections. Better understanding and care of artifacts in collections is essential for this and future generations to have cultural and artistic reference materials. It is critical to the survival and evolution, not just of Haida and Tlingit art, but to the cultures themselves, that we care for these objects appropriate to the materials from which they are made for future generations to study and from which to learn.

Just as the master artists of the Renaissance had to reconstruct the materials and techniques used by the ancient Greeks and Romans, so must we reconstruct the materials and techniques used by artists on the Northwest Coast in the past. The technology available to us today provides a means of studying the materials, tools and techniques used by ancient people, allowing us critical insights into their lives. We now have the means to better understand how materials like vivianite behave over the long term and under a variety of conditions. This could lead to different methods of storage and conservation in order to protect and preserve artifacts so future generations have these references to the past. By using modern technology to identify materials, we finally have the ability to take advantage of all the best knowledge and technology of the past, combined with the best knowledge of the present, to inform and create a more informed and congruent future.

Acknowledgments

My deepest thanks to Owen Walker for happily answering 12,962 questions; to George Mustoe for his generosity; and to Heidi Gustafson for everything.

Notes

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