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Binding Ochre to Theory

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A very special ‘Thank You’ to my parents,
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ABSTRACT

Widely found throughout the archaeological and artistic records in capacities ranging from burial contexts to early evidence of artistic expression, red ochre has been studied in archaeological and art conservationist communities for decades. Despite this, literature discussing binders is disparate and often absent from accessible arenas. Red ochre is important historically because its use can be used to help further the understanding of early humans, their predecessors, and their cognitive capabilities. However, there is not much written speculation on the processes involved in binder selection, collection, and processing. Based on the idea of these three activities associated with binders, I propose a schema for what the use of already prepared and obtained items doubling as binders might look like in the archaeological record. Using an experiment in which I used red ochre mixed with various binders to paint standardized shapes on a rock surface, I propose ways in which more experiments could be done in this vein. I suggest ways in which scales of desirability can be created based on different traits painters might have found important in the binder selection process, such as ease of paint reconstitution, texture of the paint, and the appearance of the paint mixture once on the stone. This research is one small step in the direction of expanding and diversifying the literature on binders in prehistoric paintings, and opening new avenues of conversation about the choices and motivations of early painters.

INTRODUCTION

One can argue that red ochre is one of the most widespread and important pigments of the ancient world. Its use spans continents and time periods, and it is still available and used today. Ochre has been found on cave walls, interred remains, pottery, weapons, and other personal effects, and it has been used as body paint. Each of these uses has significant and differing implications about what hominins performing these behaviors are capable of, successfully adding more depth to and shedding more light on not only us, but where we came from as well. Red ochre use has bearing on not only cognitive capabilities and distinctions, but also behaviors that are important in social function, ritual action, and economic planning and usage. Whether we wish to understand modern humans or human history, it is necessary to learn as much as possible about ochre in all of its uses and iterations.

One of the oldest yet still quantifiable contexts (in terms of quantity, quality, and dating) of red ochre use is likely its inclusion in the record via painted rock art. Its perseverance in the archaeological record and widespread occurrence coupled with inferences that can be drawn about early hominins makes rock art an ideal context in which to study red ochre use. Portable items do not preserve nearly as well as paintings on rock; so while they are useful in their own right, there are fewer examples to look at, and less widespread use of the same technologies. It is also the case that rock art is for the most part impossible to move from its original location; so interpretations can be enhanced by the original context of the painting, which may even have a site associated with it, and its

relationship in space to other known occupation, activity and painting sites. In the context of this paper, red ochre will be discussed in respect to its relationship to rock art and binder/vehicle selection, but first it is necessary to provide some clarification regarding red ochre is, at least in the context of this experiment.

Red ochre is a powder made of clay sized particles of one of many iron oxides. It has the distinction of being one of the most commonly used pigments made of iron. It is hematite in rock form, which comes in different colors; some of which produce brick red powder when abraded. Other common pigments made of oxidized iron ore include yellow ochre, purple ochre, and brown ochre (goethite). The other frequently used iron pigment, yellow ochre, is hydrated red ochre and can change in color from yellow to red if exposed to conditions that are conducive to the color change (Hirst), specifically extreme heat (Wreschner 1976:717). The same is true for brown pigments made from hematite (Hirst).

While in some cases it is obvious "that liquid ochre paint had been applied by finger" (Marshack 1981:189), what these early artists used to make their red powder applicable is not. The technical term for this part of the paint is the vehicle and/or binder. In this work the term binder is used almost exclusively to mean both terms, although it should be noted that some of the materials suggested and discussed are closer in form and function to vehicles (materials added to paint to make it liquid/workable) than they are binders (materials added to paint to make the pigment adhere to the surface being painted) (New Mexico Institute of Mining and Technology 2011). Examples of binders for red ochre in paint-making mostly come from ethnographic accounts, and they are rarely tested for when conducting scientific analyses of rock art.

According to Rijssen (1990:58), the reason that “very few laboratory analyses have been attempted” is “because of the need for large samples and the difficulty of obtaining these from rock paintings without destroying them." In the name of preservation, it is understandable that more research has not been done in the vein of identifying ancient binders, especially considering that after all these years the art may be tainted with particles that have blown in or otherwise been introduced after the original artist completed their work. Still, since new technologies such as X-Ray Fluorescence (XRF) are making it possible to do non-destructive analyses, so this will hopefully change in the future (Newman and Loendorf 2005).

Ochre has been studied in archaeological and art conservationist communities for decades, but the same handful of questions are always being asked. Many articles focus on the significance of the color red, the symbolism of blood as a binder, and the implications this may have for the development of early humans and language. Others discuss red ochre in relation to other aspects of prehistoric life, or otherwise categorize the paint itself as part of a bigger picture, without questioning it more than is absolutely necessary and therefore bringing questions of binder usage into consideration. It is common for papers to list possibly used or known binders in a single sentence, and then shift their focus back to the more pressing aspects of rock art, with little more than a possible clarification of a binder source that is particularly unfamiliar or strange to modern audiences. The reasoning behind binder selection is very rarely mentioned (with the exception of blood). Furthermore, literature discussing binders is disparate and often absent from accessible arenas. I would go so far as to say that this area of archaeology does not engage very

heavily with theory at all, and at the moment has yet to be explored to even a fraction of its full interpretive capacity.

I propose that more attention should be given to learning about and identifying the binders used in rock art of the past. Because there is not a strong history of scholars asking about and placing emphasis on binder selection and use, extensive research into other avenues of rock art scholarship was necessary to cobble together coherent statements in this paper. Researchers have historically been more interested in color symbolism and the subject matter of paintings, which are important aspects of rock art, but definitely not the complete picture. It is possible that, in this neglect, we have been missing some important part of the making and meaning of prehistoric art. It is also possible that binders were just a means to an artistic end. The only way to know this with any certainty is to do more in-depth studies, to ask the right questions, and to compile all the data, past and present, so that conclusions about the creation, meaning, and implications of rock painting can be attempted to be drawn.

These in-depth studies should include, but not be limited to, experimental designs that grow out of the field of Experimental Archaeology. Experimental Archaeology is "the fabrication of materials, behaviors, or both in order to observe one or more processes involved in the production, use, discard, deterioration, or recovery of material culture" (Skibo 1992:18 qtd in Ferguson 2010:1), and is useful in answering questions about process and the experience of working with specific examples of material culture. The experiments outlined below come out of this tradition, but take the whole process one step further and encourage incorporating the results into a discussion of theory. The specific

theory recommended, that of Optimal Foraging, is a theoretical framework that has been borrowed from biology and/or economics and is used to explain time management and resource acquisition by hunter-gatherers (Bettinger 1991:83-34). While usually applied to food-gathering techniques, I propose a restructuring of these schemata to use different scales against which to run models of binder collection and selection, maximizing for a number of different traits that will be decided in the final experimental design instead of energy, which is the maximizing factor in the traditional version of the schema (Bettinger 1991:83-111).

Unsurprisingly, there isn't much written speculation on the actual processes involved in binder selection, collection, and processing, but I propose that in order to address possible distinctions between items collected specifically for paint-making, and those that are not research done on what an assemblage might look like in which prehistoric painters were selecting binders from among the materials they already had close at hand. Using models of Optimal Foraging and original experiments, I propose how one would create a schema for what the use of already prepared and obtained items doubling as binders might look like in the archaeological record. In order to create the hierarchy of materials to apply the models to, I recommend experiments in which one uses red ochre mixed with various binders to paint standardized shapes on a rock surface. This way, one could devise scales of desirability based on different traits painters might have found important in the binder selection process, such as ease of paint reconstitution, texture of the paint, and the appearance of the paint mixture once on the stone.

Research on red ochre use and binder selection in rock painting on different continents and in distinct eras and contexts has been used as inspiration for generating important and unasked questions. Some of the questions raised in this thesis include: what binders were used and how much effort was required by their creators in procuring them? Once these questions were raised, one could develop ways in which to answer them. The most obvious way to do this is through the use of experimental archaeology, which would give us clues into what it was like for early practitioners to paint with ochre on rock. In response to these questions, common binders included fats, oils, water, plant juices, and bodily fluids and we are unable to answer the second question about effort until more research has been done on the matter. This research is one small step in the direction of expanding and diversifying the literature on binders in prehistoric paintings, and hopes to open new avenues of conversation about the choices and motivations of early painters to those that interact with theory and expansion.

LITERATURE REVIEW

In looking into literature on red ochre, one finds a relatively large percentage of the existing scholarly articles deal with the same few themes. These include but are not limited to: descriptions of various prehistoric sites in which ochre (among other artifacts) has been found, descriptions of rock painting sites, suppositions on the implications of ochre use and its relationship to the development of the modern human mind, and speculations on the meaning behind various uses of ochre as found in the archaeological record. There are instances in which articles overlap in more than one of these categories, and a few instances in which they fit into none of the categories (and in such cases they tend to be the only articles of their particular type); but for the most part, the majority of the literature can be neatly filed into one of these groups. Other avenues of research on red ochre and binders in rock painting lead to ethnographic accounts of specific groups, scientific articles on dating techniques, and the occasional much sought after but not particularly relevant experimental article. As someone interested in binders and the process of making the paints, it was necessary to examine seemingly unrelated or tangentially relevant articles or ethnography to tease out the information on binders that was being sought after.

As this literature review is attempting to span the large and often interdisciplinary categories of red ochre and rock painting, it is important to note general trends in the research that are available should one wish to explore them. However, most of the following trends will subsequently be ignored as they have been deemed more irrelevant

than the other aspects of ochre use that have been chosen to be explored in this section. First and foremost, rock paintings that contain red ochre as a pigment have been found throughout the world, on every continent except for Antarctica. Due to a dearth of scholarship that focuses on South America, most of Asia, or North America outside of California, these areas are being left out of the discussion. There is so little scholarship on areas of America outside of California (including south America) and Asia that it was necessary to resort to using Google to search specifically for information on South America and Asia in order to even be sure that there were indeed sites with evidence of red ochre use on those continents; they simply do not show up in scholarly search engines. It should be noted here that there is available research on petroglyphs, especially in South America. However, as this type of rock art consists of etchings in the stone (or the removal of the outermost stone layer which has been discolored with exposure and time), and has little to do with red ochre, I will not be discussing it further.

Beginning with petroglyphs, this piece is specifically not discussing certain areas of rock painting that have had the honor of having profuse scholarship previously done on them. For example, there is plenty of information on red ochre being found in burial contexts. While this is interesting, and related to the discussion of the finding of red ochre in sites belonging to our pre-human ancestors, this piece will not be concerned with red ochre as found in burial contexts. It will also not be examining the practices of body painting (although fascinating), or decorating of personal and useful artifacts such as arrows, atlatls, or pottery in any real non-binder related detail. It will not cover the use of ochre in hafting, or other paste-making, and most importantly there will be no speculation on the meaning or role that is played by color in the minds of our deceased relatives. This

piece will especially refrain from drawing any sort of parallels between the ochre and "life giving blood," as Wreschner (1976) is wont to call it.

Another interesting yet unexplored area of rock painting is the relationship between it and shamanic states of consciousness (Whitley 2000). While it is notable that many symbols in rock art look like the entopic phenomena that all humans are capable of seeing while in an altered state of consciousness, the specific imagery or content of rock art paintings is not the focus of this thesis. At this point it is rather safe to say that this literature review, while expansive in scope, does not attempt to even pretend to touch on everything related to red ochre and/or rock painting, and that there are multiple interesting and somewhat relevant articles that do not make it out of the bibliography and into the discussion.

The ideas and content that are taken from the literature, however, are intended to give a relatively brief and informative background on rock painting in archaeological and historical contexts. This section is organized first by time and then by location because it is important to recognize similarities and overarching trends in history first. In doing this we recognize the synchronous nature of the actions involved in rock painting before we become caught up in the differences between the continents. These distinctions between Africa, Europe, Australia and North America are made all the more particular by the tendency for each continent's body of work to have its own set of themes and main focuses.

EARLIEST KNOWN SITES

Red ochre has been found at multiple sites that are attributed to hominins that came before *H. sapiens* including *H. heidelbergensis, H. helmei,* and *H. neanderthalensis.* Its collection and use across time and space make it one of the few material items to continually appeal to members of our genus. One of the earliest sites at which evidence for use has been found is also the earliest dated Middle Stone Age deposit in Central Africa; the site, known as Twin Rivers, is located in Central Zambia. This particular site has been dated (by using a mass spectrometric uranium series dating technique) to 400,000 BP, and is attributed to *H. heidelbergensis*, specifically the culture known as Lupemban (Barham 2002: 183), which intermittently inhabited the area for upwards of 100,000 years. During this time they collected and transported pigments, among them ochre, to the site. The particular iron-containing compounds at Twin Rivers are thought to be used for their pigmenting qualities because there are also iron compounds in the assemblage that require more processing. It would not make sense to harvest and process more than one source of iron if the residents were only using it for medicinal or other non-pigmentary functional uses, as it would be a waste of time and energy (Barham 2002: 188).

Ochre has also been used in Europe since at least 300,000 BP. Some of the earlier sites there, like Terra Amata in France, and Ambrona in Spain, were once attributed to *Homo erectus* (Marshack 1981; Wreschner 1980: 631), but it is presently thought that early sites should be attributed instead to *H. heidelbergensis, H. rhodesiensis,* and *H. helmei* (Barham 2002: 189). "According to Wreschner (1980:631)," via Erlandson and Descantes

(1999: 518), "ochre may first appear in the archaeological record among an Acheulian assemblage from an Olduvai Gorge site (BKII) dated to about 500,000 BP." They also note that "red ochre is relatively common in archaeological sites," an unsurprising observation once one considers that what is believed to be the earliest mining site, Lion Cavern at Ngwenya, in Swaziland, is an ochre mine (1999: 518).

At sites such as Twin Rivers, the use of pigments by makers of Lupemban (or other) tools "adds an extra dimension of behavioral complexity to the interpretation of the site" (Barham 2002: 188), which in turn adds an extra dimension to studies of hominins and human origins. For example, archaeologists suspect that because of the wide variety and intensity of colors found in some Acheulean sites, the ochre was heated, likely with fire, to produce changes in it. This behavior is more complex than simply collecting red stones, and suggests that something more than just plain color preference may have been occurring (Wreschner 717: 1976). This is important in helping to identify the cognitive capacities of early hominins and helps shed light on the early signs of the capacity for symbolism, individualization, art, representation, abstraction, and even ritual. These considerations are in turn are important in the development of language and ultimately culture, two concepts that arguably make our species different from our mammalian and even hominid relatives. Even if the mental capacity for complicated representative language began in *H. erectus* or *H. ergaster*, it would still require physical modifications that occurred in the later *H. heidelbergensis* and *H. neanderthalensis* to continue to change until we ended up with the modern hyoid bone and the ability to make the sounds that can be heard in our languages today, but I digress (Boyd and Silk 2008). The point is that there is much speculation on red ochre's meaning to and influences on precursors of modern humans.

EUROPE

Some of the most famous prehistoric (Paleolithic) rock art is found in Europe, especially in France. One of the first sites found in Europe was Altamira, rediscovered in 1869, in present day Spain (Mirel 1962:106), years before it would be recognized for what it actually was. The level of preservation and technical skill of the paintings at the site were such that early anthropologists did not believe that it was actually as old as it is until another site, La Mouthe, was found in France in 1895, and then followed shortly thereafter in 1901 by a subsequent site, Font-de-Gaume (Van Ness Myers 1917:100).Font-de-Gaume is not noted as having any spectacular features, but it is near the ever popular site known as Lascaux, which was discovered 39 years later in 1940. It has been said that at Altamira, "the technique of painting in color is the most highly developed of all the European cave art stations," and that along with Lascaux in France, it is one of "the most splendid of the ancient picture galleries" (Mirel 1962:106).

Lascaux is important not only because it is well known, but also because it is well preserved, contains many separate caverns of art, and it is comparable to Altamira in age and scope (Henry 1941:62). One of its more impressive features is its paintings of aurochs (now extinct) that measure up to 18 feet in length (Mirel 1962:106). Another French site, Grotte Chavet, which is dated to 30,000 BP, is important because it has early examples of the techniques of shading and perspective. Grotte Chavet is also of interest because there are remnants of ancient fires in the caves, which may (or may not) have been used in paint preparations (Balter 1999).

Overall there is little to say about cave painting sites in Europe that have ochre use in them. One notable feature of these sites is that the paintings are all inside caves, in some cases very deep inside of them in hard to reach caverns In France these caves all seem to be of the same type, "narrow subterranean water channels worn by ancient underground tributaries of the rivers of the country" (Van Ness Myers 1917:102). Sunlight does not penetrate these caves to shine upon the ancient illustrations (Van Ness Myers 1917:102). Certain sites have interesting attributes, and lots of attention in the literature is placed on the content of the works, intention, meaning, and the implications of all three. A few people have made interesting charts based on content and location such as Marshack and Mac Curdy (1930), and there are undoubtedly a couple of literature reviews by other scholars that focus primarily on the European scholarship (Conkey 1987).

In Conkey's (1987:422-424) relatively extensive review of the literature on European cave paintings, even in the section on experimental archaeology, she noted that there is literature about the pigments, about the processes of making the paints (one sentence, referencing unattainable articles about Lascaux), and even about recreating specific images, but she doesn't so much as mention binders. They are simply not important to most scholars of rock art, and are definitely underrepresented in the literature. This is even more so in Europe because there was not the ability to conduct ethnographic studies that could supplement the knowledge; and, unlike the caves in Texas that Reese et al. (1996) looked at which were peeling and thus able to be chemically analyzed, European rock paintings are exceptionally well preserved.

AUSTRALIA

Australia is different from Europe in respect to its rock art. While red ochre use has been in Australia for thousands of years, due to the tradition of painting over older work, degradation through natural forces, and the persistence of groups that create rock paintings, the art here seems to be much younger. Due to Anthropology's proclivity towards ethnographic studies of the aboriginal peoples of Australia, ethnographers had already touched upon Australian painting practices, and could look deeper when research on rock painting became popular in anthropology (Worms 1955:551). An interesting characteristic of Australian rock painting that was identified during these ethnographies is that unlike on other continents, where painting over is evidenced without mention of retouching, the people of Australia are known for their tradition of retouching old paintings that still have cultural relevance today (Blundell 1974:216). In Western Australia there is a site called Walga Rock where chemical and mineral analyses have been conducted on samples obtained from peeling paint. According to the Walga Rock report, these samples did not show any evidence of organic binder use; the author also hypothesized that water and ochre were mixed in the mouth and spit forcefully through pursed lips or teeth to create an airbrush effect (Clarke 1976:140).This particular site (like many other Australian sites) has experienced quite a bit of weathering, thought to be caused both by humidity and exposure to run-off from rain or another water source. The latter is more influential in degradation as there are other painted sites nearby that are known to be older, but that are in better shape than the ones examined here (Clarke 1976:141).

The paintings of Northern North Kimberly (in the NW) are thought to be old (although no estimate was given) based on the extent to which they are faded. This is more evident in the sites that have been exposed to the elements, as paintings that are more protected have maintained some of the qualities of freshly painted sites. This is especially obvious in places that have partially protected paintings, where part will be severely abraded by weathering and rainwater over time while another part will not appear to be damaged at all (Worms 1955:555).

Dating has been conducted on some of the sites, yielding mixed results. In Northeastern Australia, the paintings are all believed to be less than 5400 years old. One site, known as the Lookout Shelter is dated to between 1900 and 1600 BP (David and Lourandos 1998:205), which is fairly young in rock painting terms. Further to the Southwest, however, at the limestone outcroppings known as Rookwood, Mungana and Chillagoe, traces of paintings dated as far back as 28,100 + 400 BP have been found (David and Lourandos 1998:206). This puts Australian rock art firmly on the timeline of the archaeological record contemporary with sites in Europe, and continuing into the present, with evidence of continuity along the way.

As far as methods of painting go, it is known that contemporary aboriginal painters employed a few different binders including using dry pigment to draw, like chalk. Other known examples of binders are water, animal or fish fat, and orchid juice (dendrobium). Application styles included hands/fingers, brushes constructed from chewed sticks, or feathers tied to sticks (Wilcox 1959:97). Keeping with the theme of the logistics of painting, there is an ochre mine in Western Australia called Wilgie Mia. This mine is in the Weld Range of the Murchison Region of Western Australia. This site is important because it was

still being mined when Europeans first arrived in Australia and continued into the late 1930s, when the Europeans interfered. Wilgie Mia seems to have been carved out over "many tens of thousands of years" (Clarke 1976:135). This mine is also notable because it was the main source of ochre for the middle of Western Australia. Ochre mined from this site was still being used for body paint in 1976, but there was no evidence of contemporary use of it for rock paintings (Clarke 1976:136).

An interesting feature of Australian rock art that has not been mentioned in the general literature of other continents is that there are quite a few sites that have one color painted solidly on the rock and then other forms are painted over this base coat. It is described in the literature as a process that happens within a relatively short period of time by a single artist (Mathew 1897:473; Worms 1955:551), and has not been reported in any of the reading I have done on sites on other continents, although I would not go so far as to say that it never happens elsewhere. Examples such as this one, of specific behaviors that have bearing on rock painting, are made possible by the sheer quantity of ethnographic and archaeological data that exists for this continent. As a function of this bank of knowledge, the rock painting tradition of Australia adds many facets to the understanding and discussion of rocks painted by hominins.

AMERICAS

Similarly to Australia, the knowledge bank of American rock painting is exceptionally large, but this distinction is limited to California. This is because for various reasons, a relatively large percentage of the American rock art discourse is centered in California. Californian archaeologists also have a tendency to inquire more deeply about

binders, so this section will focus more on the different binders used in the U.S., focusing more on California and specifically the Chumash, who are commonly discussed in the literature (e.g., Whitley 2000; Campbell 2007; Driver and Massey 1957). In contrast, it is important to note that there are not many rock paintings east of the Mississippi River. This may be because of a lack of ideal painting surfaces, that there is no tradition for it (although there is a tradition of petroglyph creation), or that they existed but the humidity and dampness of the climate has removed any evidence that they were once there (Grant 1965:117).

As far as making paint goes, the native peoples of America had to obtain ochre just like everyone else. It is known that one of the earlier ochre mining sites is believed to have been used by Clovis and other Paleo-Indian groups at the Powars II, located in Wyoming (Erlandson et al. 1999:518). As for more recent ochre mining and trading, most of the literature points to California. According to Campbell Grant (1965), ochre occurs only in a few places in California, and those deposits are a dull brownish color. Some groups, such as the "Paiute and Cocopa Indians intensified its hue by exposing it to fire" (85). Paul Douglas Campbell, author of *Earth Pigments and Paint of the California Indians: Meaning and Technology,* cites a single site, Diamond Creek, as the origin of a vast majority of the ochre that was traded throughout Southern California. Sometimes the ochre had to be ground into a fine powder before it could be used to paint, but some mines, such as the aforementioned Diamond Creek, had the mineral already available in powdered form. Still, this did not make the task much easier as retrieval via the tiny mine shaft was dangerous and sometimes deadly (13-26).

All of the research that mentions ways of dealing with and obtaining ochre also discusses the formation of balls or cakes of pigment, made of wet and compressed pigment powder. These cakes could be used to make paint by the addition of binders/vehicle, but they could also be painted with "like chalk," by simply pressing them to the wall in question (Miller 1980 qtd in Wreschner 1980:693). In cases where using pigment cakes like crayons was not quite the effect they were looking for, brushes that were likely made from frayed yucca or the outer husks of the soap plant, *Chlorogalum pomeridianum*, were used by groups like the Chumash and Yokuts. Other application methods included a sharpened stick, finger, or drawing with a lump of unprocessed hematite (Grant 1965:86). Most of these other application methods, however, required more than just dry pigment.

To any average modern person that has ever used watercolor paints, and possibly even those who have not, water is the first material one thinks to mix with something to make it into a liquid. This is applicable to more than just my modern American mind, as water truly makes a wonderful binder:

> "Water, the most obvious binder (sometimes also described as a vehicle), was a medium commonly employed by the Shasta, Wintu, Nisenan, Yokuts, and many others. Likely all groups mixed pigment with water. It effectively penetrates porous woods and stones. Experiments by Claude Couraud (in Bahn and Vertut, 1988) have shown that surprisingly it penetrates and fixes pigment to a rock face far better than fat or other organic substances which tended not to penetrate and hold in humid rock wall surfaces. Alanah Woody and Oyvind Frock in recent experiments also found water the best binder for rock surfaces." (Campbell 2007:87)

Sugar water was another option used by the Kumeyaay (Diegueño) and Mohave, specifically in pottery glaze. The Kumeyaay mixed ochre with water that had previously been soaking mescal (*Agave deserti*) for 24 hours. The mescal had also been repeatedly squeezed during the process to get "the sweet agave syrup out into the water," because the sugar in the solution helped to set the pigment during firing. The Mohave did the same, except they used "the sugary juices of the mesquite bean" instead. (Campbell 2007:93).

Another water-based, readily available liquid is saliva. Admittedly it is a little unpleasant to think of using as a modern minded person, and in actuality it is even more of an experience than you might expect (I speak from personal experience with using saliva as a binder here), but it is something that will conveniently be present with you wherever you are even when other liquids are not (as long as one is not dehydrated). On top of the convenience benefit, saliva is actually better as binder than plain water. It is the case that "saliva, a very complex liquid substance, bound pigments for the Klamath, Modoc, Shasta and many other groups. Some of its myriad of components react with certain pigments in ways that improve the binding quality of the paint. Gorden (1996) listed calcium carbonate as one of these useful saliva compounds" (Campbell 2007:87-88). While an effective binder, saliva is not the only bodily fluid that has been noted as used in rock (and other) painting traditions.

Blood, of course, was used as a complete paint (pigment and binder) and also as just a binder, but mostly in the case of black pigments as it is known to corrupt the color of other pigments, turning them into a brown that gradually gets darker over time. It was found that a mixture of human and pronghorn antelope blood was the main binder in a

black pigment cake housed in a bivalve shell of Chumash origin. The Chimarilo and Paipai are known to have used straight blood (sometimes rabbit blood specifically) to paint arrows and throwing sticks (Campbell 2007:93-94).

Despite the usefulness of water and water-based vehicles, sometimes oils and fats were used. It is said that the Chumash "obviously used water" as a binder, but that in rock painting, oil was used instead to "make a permanent waterproof paint" (Grant 1965:86). These oil based paints were unlikely to run if wet, but also did not absorb into the rock in the same way water-based paints did (Campbell 2007:88). The Modoc used deer grease, and "fat (or grease or marrow) was a common binder everywhere" in California (88). The fat of the ground squirrel or snake oil was also used to make a long-lasting paint for rock surfaces by the Fernandeño (89). Unfortunately, "on fixed objects, over time, fat tends to darken and obscure pigments," so it is possible that some people chose water-based paints instead for this reason (89).

Glue was also used as a binder as "some groups used animal-based glue," and a Yurok informant's particular glue was "chewed air bladder of a sturgeon, spit into a bowl and heated" (Campbell 2007:93). Campbell also notes that "The Karok made a similar paint base from chewed salmon skin adding a chewed glandular substance from the throat of the sturgeon" (93). The Shasta used masticated charcoal mixed with bone marrow (so they had saliva in there too) (88), similarly, the Cocopa effectively extracted oils added saliva by chewing pumpkin seeds, and the Hopi chewed many different kinds of seeds for the same effect (89). The Nisenan (and likely other groups) utilized acorn oil as a binder (90).

More surprisingly to me at least, the Achomawi and Wintu groups, among others, used pine pitch (sap) as a binder (Campbell 2007:90-91). Pitch was also used by the Luiseño and Gabrieliño, who according to Harrington (ca. 2000s qtd in Campbell 2007:91) also added oil made from the seeds of wild cucumber (*Marah macrocarpus,)* which had the added benefit of making the mixture less sticky, more workable, better at penetrating surfaces, and slightly less viscous. Paint made with both components was also glossy when dry (91-92). Either substance was also acceptable and appropriate to be used with pigment independently of the other, but *Marah macrocarpus* is more commonly cited in the literature at large (Timbrook 2007:123; Martin 2009:87).

According to Campbell, "It is not known exactly what type of binder the Chumash added to their pigment, but it is reasonably certain that it was the same or similar to that of the Yokuts. This group typically made their binder of the juice of the milkweed (*Asclepias fascicularis*) mixed with oil extracted from the crushed seeds of the chilicothe (*Echinocystis macrocarpa)*. It is also likely that animal oil and the whites of bird egg were sometimes used" (2007:86). Other literature, however, cites the Chumash as using wild cucumber oil (Grant 1965, Timbrook 2007:123; Martin 2009:87). Martin suggests that there are also other plants, such as *Juglans californica*, the California walnut, which produce oils that would be suitable for binding (90).

For reasons that are not entirely known but sometimes speculated on, it has been noted that in America, rock paintings are mostly limited to the West Coast (Mirel 1963:107). Still, if you look hard enough you will find that there are sites in other states. In Texas, chemical tests on peeling pictographs have revealed that the bone marrow of an

ungulate closely related to bison was used as a binder in their red ochre paint (Reese et al. 1996:378). Bone marrow was used outside of California, as other binders (that are not native to and exclusively found in California) are used in other places as well. This can be corroborated by a statement from Driver and Massey saying that in the Pacific Northwest, "paint of red, black and white pigments mixed with grease was applied to the bodies of both sexes on gala occasions…" (1957:318). Body paint was also used by the Hopi (368), in the Southeast (319), and in Meso-America (372), although no binders are specified. It was also common for groups to paint designs on buckskin shields which they would carry into battle (363), and totems (394). Despite what the silence in the literature seems to suggest, paints and most definitely binders were not limited only to California in North America.

AFRICA

As has already been stated, some of the earliest, sites that have ochre associated with them are in Africa. More recent sites that show evidence not only of ochre collection, but manipulation as well, include Blombos Cave, South Africa in which was found a "processing workshop" complete with evidence of use of a liquefied red mixture that was held in two *Haliotis midae* (abalone) shells (Henshilwood et al. 2011:219). Beginning with ochre in rock form, archaeologists found evidence of grinding practices used to make powdered ochre for a liquid that was likely an ancient paint. This site has been dated to the Middle Stone Age, approximately 100,000 BP, much later than the sites examined in the earliest sites section. While it is unclear how the red liquid was used, it is apparent that components of the toolkit were reused, so there was some habit of grinding up ochre and mixing it with other materials (222).

According to Woodhouse (1969), deposits associated with paintings are even later still, mostly appearing in the record during the Late Stone Age, approximately 7,000 years ago (46). Barham posits that while ochre was collected and purposefully introduced into Acheulean sites, quantities that would suggest actual systematic collection do not show up in the record until the Middle Stone Age, although the tradition "has roots in the Late Acheulian" (2002:189). He also attributes the behavior to both *H. heidelbergensis* (or *H. helmei*) and *H. sapiens* (182).

There are over 2,000 known sites that contain rock paintings in Southern Africa. For this reason, it has been called "the world's greatest storehouse of prehistoric rock painting" (Woodhouse 1969:44). For the most part, these paintings have not been dated. The ones that can be dated have subject matter such as horses, carriages, mules, and European-style clothing. During this period of rock painting, the most commonly used color was "a dull red," often by itself (46). There was also use of two colors: red and white, and three colors: red, white, and black. Black was also often used by itself (Marshack 1981:46). It is possible that white was used alone as well, but it is known to degrade faster than other colors and thus has a tendency to fall out of the archaeological record quickly and easily, so there is no evidence to support this.

The discovery by Wendt at the Apollo II cave in South Africa, of a tricolor rock painting dated to approximately 27,000 years ago (during the early European Upper Paleolithic), provided evidence that multi-color, skilled paintings were not limited to Europe at that time, and did not filter into Africa from Paleolithic Europe, as may have previously been proposed (Marshack 1981:190). Later paintings in Zambia are believed to

be around 15,000 years old, coming from the Late Stone Age. Zambian paintings are often only briefly mentioned and quickly disregarded in the literature because of their subject matter, which is often thought to be simplistic (Phillipson 1972:313). Because of a lack of paintable rock in Southern Zambia, paintings tend to be in the other regions, specifically the East, which is believed to contain the newest of the Zambian rock paintings (320).

Speaking of suitable rock faces, most of the paintings in Africa are done on walls that are open air (as opposed to paintings in Europe, which are tucked away in caves) (Marshack 1981:44). Paints were believed to be made from pigments ground in a stone mortar, and stored in horns collected from small antelope. The application was likely to have been done by any of the following: "fingers; brushes made of animal hair attached to the end of a stick; a flexible piece of bone; a feather sharpened to form a quill pen" and sometimes "dipping the end of a hollow reed in the paint and pressing it to the rock face to produce tiny circles." Probable binders used in these paints included "the milky juice of the euphorbia, the contents of an ostrich egg, the blood of a freshly-killed eland, animal fat, or even, tradition has it, the urine of the hyrax or rock rabbit" (46). Rudner adds "plant fat, bile, water, milk, plant sap, gum, honey, saliva, salt, beeswax, and gelatin" as well as hyraxeum (mixed hyrax urine and feces), blood serum, termites, nut/seed oil, and no medium at all to the list of binders cited in the literature. She then proceeds to strike honey, gum, beeswax, vegetable fat, hyraxeum, urine, bile, eggs, salt, and gelatin from the record (1983:14-17). According to Wilcox, there is no evidence of water-based or dry pigment use in South Africa, and animal fats, saps and juices were used instead (1959:97). Henshilwood et al. provide a very specific recounting of how they believe paints were prepared at Blombos Cave:

> "We infer that manufacturing proceeded as follows: Pieces of ochre (FS1 and FS2) were rubbed on quartzite slabs to produce a fine red powder, and some were knapped with large lithic flakes. The ochre chips resulting from the latter were crushed with quartz, quartzite, and silcrete hammerstones/grinders. Quartzite grinders were used to crush goethite or hematite-rich lutite. Medium-sized mammal bone was crushed, probably with a stone hammer. The red or reddish brown color and cracked, flaky texture of some of the trabecular bone suggest that it was heated before crushing, probably to enhance the extraction of the marrow fat. The hematite powder, charcoal, crushed trabecular bone, stone chips, and quartz grains and a liquid were then introduced into the Haliotis shells and gently stirred (2011:222).

Based on the evidence they found, they believe the main binder to be bone marrow, something that did not make it to either Barham or Rudner's lists.

Aside from an article by Ione Rudner (1983) claiming that a few scholars, including E. Denninger and herself, have experimented with pigments and binders, it appears that minimal experimentation has actually been done with binders and ancient paints. According to that same work, most of the supposed ethnographic evidence for which binders were used in rock paintings in Africa is based on hearsay and the repetition of accounts which may not be wholly accurate. Rudner suspects that the people who claim blood to be a likely binder in African rock paintings are mostly quoting each other, and that the experimental archaeologist Denninger, who did experiments with sheep's blood and ochre, used faulty logic and made multiple contradictory statements in their paper. Admittedly I find that Denninger's contradictions were just their way of covering their

bases and allowing for the possibility that they were incorrect, but Rudner's point still stands that an explicit statement was made, that "blood or blood serum had been used almost without exception as a binder in all the rock paintings examined in South and South West Africa," and that it was taken up by others and quoted without their necessarily finishing or understanding the rest of the article the statement came from. Since then, fieldwork done with present-day Khoisan peoples has shown that fats, sometimes mixed with water or saliva, were often used as binders for body paint (1983).

While Rudner (1983) includes tables that show the results of some experiments with binders and pigments, it is unclear whether these are results Rudner obtained from a third party or ones that she created herself. Furthermore these results say nothing about what it was like to experience any of these paints, how they compare in terms of ease of use, if they smelled, how they looked on rock, or other qualities that may have been of interest to painters of the past. The results were simply a description of what pigments and binders were mixed, and what color was produced. This is where the need for more experiments comes in.

COMPARISONS

As the basic feel of the different subcategories of rock art research divided by continent has already been established in the previous sections, this one will be relatively short. In general, the ages of rock art sites across the continents overlap in dating where dates are known, and often continues into more recent times, allowing ethnography to be used to supplement the record. In cases where the tradition did not continue, other means of inquiry are required, such as experimental archaeology. This is even more important

because one cannot extrapolate from one painting tradition to another as it is known that in different places, different binders, styles, and rock formation types have been used. Europe tends to have its well-preserved rock art in caves with rather controlled ventilation, Africa tends to have it on large exposed rock shelters (Marshack 1981:44), and Australia's constantly weathered art is found on whatever type of large rock surface is available (Worms 1955:555). For the most part it seems that water is used as a binder across time and space in contexts where we have ideas of what binders were used, and depending on which set of sources we use, it seems that fats, oils, bodily fluids (saliva), plant juices and straight ochre are used across the globe as well.

Still, although we know that specific groups liked specific binders, we have very little knowledge of why certain binders were used more commonly and in more contexts. Since it is recognized that there are trends in binder selection throughout space, and any knowledge we can garner about possible rationales of long-dead artists is valuable to us as historians and scholars, it would be foolish to not even begin to attempt to figure out what made these certain types of binders more successful and recurrent. This is why experiments on the matter are not only a good idea, but absolutely necessary.

PREVIOUS EXPERIMENT

Given that this proposal is building on prior, unpublished work, it would be advantageous to include methodology from my 2010 experiment and its results to bolster the ideas presented here and offer some insight into why parts of this experiment are suggested to be carried out in the specific ways they are advised to be done. Hopefully, if someone were to carry out my proposed experiments, they could read this section beforehand and avoid making the same beginner's mistakes that I originally did. Furthermore, if they choose to use some of the same materials (as will undoubtedly happen at the very least with water), they can look to my results for corroboration and inspiration, as they will know that someone else has gone through the same somewhat unpleasant process of mixing their saliva with red ochre for science. This possible repetition can be tied into the scientific idea of testing and re-testing to see if one gets the same results by doing the same experiment as another in a different time/space. Finally, if desperate, one could also look to my wording and organization (which admittedly differ slightly from my suggested methods of presentation) to see how it could possibly be done. It should be noted at this point that the original experiment was conducted and written up in a fairly casual manner.

My main research question was: What were likely binders that early Californians/humans/hominins used with red ochre as a pigment? Within this main question I had five sub-questions: (1) How did binders affect the paint's aesthetic

properties? For example, which binders made paints that were nicer looking, shinier when dry, or deeper in color? (2) How did the binder affect the ease and workability of the paint? (3) Which paint stayed put better once applied to the rock's surface and allowed to dry? (4) Which binders made the paint keep longer without needing to be reconstituted? And (5) Which binders made paints that were easiest to reconstitute after they had dried out?

Once I knew what variables to test, I compiled a list of materials needed to successfully run my experiment, which was simple and consisted of five steps:

1. Gather Materials.
2. Place binders in Marked Wells.
3. Add Pigment to Binders.
4. Mix Well.
5. Paint Rock.

Materials used were: Olive Oil, Canola Oil, Water, Saliva, Chicken Egg (both separated into white and yolk, and mixed), Whole Milk (pasteurized), Diluted Milk (pasteurized), Flat Beer, a Simple Syrup (Sucrose and Water, to the point of saturation), Powdered Red Ochre (Pottery Grade), a Large Untreated Stone, a Palette (egg carton), Fingers (for mixing/painting), Note-Taking Materials (pen and paper), and a Camera. A sink and dish soap were also well used during the course of the experiment as I moved from one binder to another.

Observations and Analysis

The first mistake I noticed during the course of the experiment was that there was too much of each binder in each well, but as I was using a single egg carton as a palette, it

was impossible to dump any of the binders without having them spill over their containing walls and mix with their neighbors. As this would have completely tainted the results, I decided to just add a lot of ochre and hope for the best. While still mixing the binders and pigment together, I noticed that the binder/pigment solution in each well looked a little different. The water looked a little like tomato juice; the saliva had congealed into some lumpy looking mess; the two oils looked dark, shiny and smooth; the "whole" egg looked frothy, bubbly, uneven and orange; the egg white looked like it did not want to mix with the ochre at all; the egg yolk was frothier and yellower than the "whole" egg; both milks were pinkish and went to white with red spots quickly as the ochre fell out of solution; the simple syrup was dark and deep looking; and the beer looked about half a shade darker than the water. I was excited to see if and how they would differ during painting. An individual analysis by binder type is as follows:

> *Water.* I started with water, which was wholly disappointing. I worried at this point, as it seemed that it would've been better had I simply not put so much water in the well to begin with. It was not a satisfying experience, as it was altogether too watery and the ochre fell out of solution easily.

> *Saliva.* The saliva was pretty gross the first time I worked with it, as I did not get it mixed particularly well in the beginning. Still, I was surprised at how smooth and matte it was. It went on thick.

Olive Oil. The olive oil was nice and easy to work with. It was shiny and went on nicely. It was pretty smooth, and more opaque than the canola oil, which was next.

Canola Oil. For some reason the canola oil didn't bind well to the ochre, and it was noticeably more difficult to get the pigment on my finger to paint with. It was not terribly consistent in its opacity, and I could clearly see the rock's surface under it in some places, which I infer meant that in those places only the oil went on. I had to use two fingerfuls to get the same sized spot painted as with the previous paints.

"Whole" (or mixed) Egg. This was both yolk and egg white in the well. It was gross to work with. It didn't bind well and it was hard to apply. It was also kind of runny and even worse than the canola oil with its transparent portions. In this case I also had to use two fingerfuls of paint to get the size of painted area I wanted.

Egg White. Egg white was by far the grossest and most unpleasant of all the binders to work with. It was also the least effective in terms of binding to the pigment and allowing me to paint with it. I didn't even want to try a second finger full of it because the first was so unrewarding. It was very difficult to get the pigment and egg white to mix enough that one could paint with it and even then there was almost no pigment in the solution and it felt very light and transparent.

Egg Yolk. The egg yolk paint had a nice consistency. It was thick, creamy, and went on nicely. It had a very good covering quality and was the most matte of the egg and oil paints, possibly even of all the paints.

Whole Milk. In the paint made with whole milk, there were two changes in color; one making the paint have more of a bluish tinge when applied to the rock, and two, a pinkish appearance with red flecks in it while it sat in the well. It was nice to work with, and relatively opaque, but kind of uneventful.

Simple Syrup. The paint made with the solution of sucrose (table sugar) and warm water was extremely pleasant to work with. It had a nice color, and lots of pigment went on relative to the amount of paint on my finger. When I applied it to the rock I realized that it was the most like modern paint, and I felt almost as though I was finger painting with something I'd used in art class as a child.

Diluted Milk. The paint made with diluted milk was not as good as the one made with whole milk. It was less matte, not as fun to work with as it was one of the thinner paints, and it was a little more difficult to get a satisfying amount of pigment on my finger.

Flat Beer. The paint made with beer was very similar to that made with water – unfulfilling, runny, and needing to be stirred constantly. It also had a very strong smell that was not quite that of regular beer, and I was happy to wash it off my finger and be done with it.

In the same vein, of smell, some (or possibly just one) of the binders had a distinct smell that intensified when mixed with the ochre and made it so that I did not leave the palette in my room overnight even on the first night of the experiment because I found it

unpleasant and slightly nauseating. Instead it sat in the hallway for a couple of days before the smell was strong and unpleasant enough that my neighbors and I suspected that something was amiss in our rooms/bathroom. A couple days in I realized that it was the paints (that I had been mostly afraid to open since the day after the experiment took place), which were still sitting in the hallway.

I opened them up briefly, noted that the milk based paints looked horrific, the saliva based one had dried out, and the beer was growing spots of green mold on a layer of beige. The other wells were all dark, congealed looking, and reddish, and I wanted to stop subjecting us to the smell as soon as possible, so I did not take a good look at any of them – something I regretted once I had thrown out the palette.

Luckily for me (and my neighbors), once the paints were applied to rock, they did not have the same propensity to smell bad, and I can actually sniff the rock without any olfactory discomfort whatsoever. It is also possible to tell just by looking at the rock, which binders were mainly water-based with substrates that didn't change the properties of the pigment at all (the non-fat and non-sugar paints), and which paints were more than just ochre suspended in water.

Figure 1: Image of the rock immediately after completing the initial experiment in 2010.

Figure 2: Image of the rock two weeks after completing the initial experiment in 2010.

One of the many aspects of the experiment that I found interesting was the change in the appearance of the oil-based paints over time. When I first painted with them they were dark and shiny like the egg and sugar based paints. However, within half an hour the oil began leeching out of the painted area and instead was migrating over the surface of the rock, radiating outwards from the painted areas and affecting the edges of their neighbors. This continued for a couple days, and then the spreading ceased. Then, the areas where the ochre remained began drying out; they lost their shiny quality and began to look more like just plain ochre powder upon rock. The canola oil paint (once the darkest spot on the rock) was, two weeks later, the most faded and washed out looking of the painted areas.

The olive oil based spot looks the worst in another capacity. The oil leeched from the painted area and made a large darkened spot on the rock both under and around the image, which serves to give the rock the appearance of being wet while lowering the contrast between the red ochre and the brown rock face. It is difficult to discern the edges of the painted area, and I would not recommend it.

I would, however, recommend some of the other binders, as they held up differently over the course of two weeks. The milk, water, and beer-based paints all dried powdery-

looking, with an interesting spotty white discoloration in the one made by whole milk, and a very slight, yet similar, one in the area painted with beer paint. They retain this quality and appear to be able to simply rub off the rock.

The oil paints, as previously mentioned, also look like dried powder on rock, with the exception that portions of the olive oil stain appear to be slightly damp powder. The syrup and whole egg paints look interesting and quite indescribable. Neither looks simply like powder on stone, but they're not shiny and have definitely dried since being laid on the rock. There are also differences between the two; the syrup is very consistently opaque while the egg is transparent in places, looking more like an accidental smear of something than a deliberate paint spot.

The only paints that remained shiny were the two with egg yolk in them. The straight egg yolk paint looks basically identical to how it did when it first went on. It dried just as shiny and thick as it was when I first applied it, and the appearance of it still being wet, while possibly desirable to some, bothers me a little as was constantly afraid that I was going to smear it.

Conclusions

At the end of painting the front of the rock, I went back and repainted with some of the paints to get a better understanding of them and how I felt about them. I also tried to use similar paints one after another so that I could compare the use of one to the use of another without other paint use in the middle. I decided right away that I felt that water

was better than beer as a binder. The two were basically the same, with the main difference being the smell of the beer paint.

I then compared the syrup to saliva. The syrup, I found, was thinner and more consistent in texture and covering capacity. It also once properly mixed with the ochre had a "good, creamy, smooth feeling" despite its being more heterogeneous originally, requiring more stirring, and being somewhat inconsistent in its covering ability/ pigment content. I returned to the olive oil, as I remembered it being smooth, but by this point I had already noticed that it began separating at the edges and was not as homogenous as the syrup. The egg yolk paint was still creamy, but I found that it was less consistent in texture and pigment than the syrup, although it was better and more effective than olive oil. In the end I decided that I preferred saliva to egg yolk (and thus by transitive property over olive oil as well), and that I prefer the simple syrup paint to the saliva paint.

When I also bring the final product (the painted stone, two weeks later) into consideration, I find that in my opinion the simple syrup paint still wins. Of all the paints on the stone, to my modern eyes, the syrup paint looks the nicest (as in it was the most pleasing hue, had the right amount of luster, no obvious degradation, and no leeching) two weeks after painting. In looking back at my experiment and considering its outcomes, I cannot help but also remember my small failures during the process. While I discovered new aspects of mixing and working with paints that I had not imagined I would notice, I also learned that there were easier ways to interact with the experiment that I created, and that certain parameters should have been standardized from the beginning.

BIASES AND DIFFICULTIES

It seems that my biases would be relevant to more than just my past experiment. My motives and background have bearing not only on my interpretations of my past work, but also how I would conceive to move forward and what I propose that someone else should do. They also affect how I would want the results to be organized and how I have framed this entire thesis. And so, I will confess some of these more pervasive biases. First and foremost, I am a female-bodied, American-born (and raised) politically liberal identifying liberal arts college student. I'm an anthropology major with an interest in hominin evolution and experimental archaeology, a minority, and a feminist in everything but name. I look at the archaeological record in very specific ways because of this. Mostly, I take pleasure in questioning and challenging conventional beliefs about anything that is taken for granted, and look for feasible alternative explanations and holes in the literature whenever possible.

I sometimes make physical art in my spare time, with the majority of my training being in watercolor (or guache) use. I also appreciate acrylics. Still, I would not consider myself a physical artist or a painter, and so I look at this from the perspective of one who dabbles in art to amuse oneself. I have been known to enjoy simple, monochrome art, and I appreciate the color red. I value texture, color, and convenience above all. I find beauty in simplicity, and always choose the least expensive or least time consuming way to achieve my desired effects . I like to indulge myself and think that at least some early painters did this as well, and so grew this thesis.

After months of research in scholarly databases, I was excited when a random Google search turned up a result claiming to be an 'Archive of African Rock Art' by a group called The Bradshaw Foundation. I imagined a well-catalogued, easy to navigate, comprehensive website that contained links to (or at least the names and possible descriptions of) all the rock art sites known to exist, grouped by Area, type, or both. At the very least it should have had links to other sites that might have more information by country. I was expecting a utilitarian site, obviously put together in the 90s or early 00s, with a lot of hyperlinks and/or tables.

Instead I found a shiny new impressive looking page that had a list of 11 titles that looked like articles; some named after specific sites, some after regions, others promising a research institute, a list of documentaries, a gallery, or two items that sound like ethnographic studies. The ones I clicked led to more similarly laid out pages, a few contained informative looking articles, but more than half of the linked pages were, like the archive itself, not what I was expecting. On the left hand navigation bar were links to more supposed archives; 14 different ones in fact, including but not limited to: Africa, South Africa, America, South America, Australia, British Isles, China, France, India, Scandinavia, World, Ice Age, etc. After less than 5 minutes of clicking through I felt completely overwhelmed by the site, unable to shake the feeling that I could get lost in the archives and still completely miss anything useful that might be hiding in there.

This is both sad and indicative of the greater literature on rock art at large. Even when you have it all in front of you, the information you want is hidden under seemingly irrelevant titles, and there's no sure way to navigate the literature without feeling as

though you're constantly missing something not only useful but important. I understand the dangers of having all of the sites listed with locations as well, as it might lead to tourism which could potentially damage sites, especially the smaller, less well-known ones that may not have yet had the chance to be examined by archeologists or for artifacts, etc. But a list of some type, or at the very least a consistent design and well thought out photo gallery that organized images by site instead of displaying all 20 images as thumbnails on the main gallery page would have been nice. There was so much potential for the archives to be wonderful. They, like this area of inquiry in general, have only begun to be recognized as important, and could seriously benefit from a few people taking it upon themselves to catalogue and organize the available resources.

However, this would be a huge undertaking, as the literature on sites crosses over into art history, national history, a few sentences buried deep within ethnography, and a few other disciplines that are even farther outside of archaeology. It was difficult enough for me to identify important/relevant sites to talk about in the literature review section that I would imagine one could spend a few lifetimes searching for and cataloguing sites and still not finish.

As I have alluded to before, the literature on red ochre and rock art is more developed in some areas than it is in others. Many of the scholarly articles and books I found in my search for information focused primarily on topics that were of little or no use in this project. This is not simply because there is no research in the areas I'm interested in, but partially because of limited access. The most relevant sounding articles tended to be studies conducted by governments to assess their country's heritage sites. Most of them

were old and incorporated into print sources that I could not even begin to fathom how to access.

There were also books that would be useful, that is, if they were the type of book that would be available in a public library somewhere and did not cost somewhere around $100 a copy. I convinced my department to purchase one of the books (Campbell 2007); it was everything I hoped and dreamed it would have been, and what I propose more books on painting and pigments of prehistoric peoples should be. Thinking back, however, the only reason I even learned of that book in the first place is because I used connections to get the email address of a certain professor who was both knowledgeable and kind enough to answer a few of my questions and give me the title of that specific volume.

In most cases, however, there was no magical book containing everything I needed or wanted to know about rock art and binder use in a particular area, and I instead had to search for the few relevant sentences that were buried somewhere within a 20-40 page article or 300 page ethnography and hope that they would be on the same page. Needless to say, months of research left me with a list of references that's only about 30 entries long. There were literally weeks in which I found nothing both useful and accessible. It was disheartening. Luckily, every once in awhile I would run across some previous scholar who'd taken an interest in binders (or enough of an interest in them) that I could find a few pages of useful information. Still, those types of work were few and far between.

While it is important that the literature be amassed in some comprehensive, navigable format, it is also important to press on and add to this already unwieldy body of knowledge. More studies that look at binder use and selection should be one of the directions that the

community decides to look further into. I know a good way to start: with the following experiment.

PROPOSED EXPERIMENT

This research design is based in part on a preliminary experiment carried out a year prior to writing this, enriched by my ideas for expansion and fixing certain oversights that were made the first time around. The more specific items mentioned (such as the urine of very specific animals or the oil of *Marah macrocarpus*) have been supplemented by additional research discussed in the literature review. Originally conceived as a standalone project, this has been reformatted to draw from models of optimal foraging theory, with the acquisition and preparation of the materials, not just their use, being important dimensions. . In optimal foraging theory, lists of foraging activities, ordered by time and/or energy requirements are compared against graphs that contain optimal foraging time, travel time, and departure times (Bettinger 1991). I propose that by paying close attention to preparation time, time required to locate the materials, extraction time, mixing time, the amount of time the created paint is viable for, and drying time of the paint on the rock, we can create our own version of this schema and use it to learn about binder selection and the possible rationales for preferencing certain binders over others.

Sometime during the course of the spring semester of my junior year, I realized that I was enchanted by the idea of painting with red ochre, and decided that I needed to work with it myself to truly understand the draw of it. Once I thought about procuring the material for myself, I started to wonder what I would mix with it to make paint. The immediately obvious answer was water, but then I started thinking about paints in the Renaissance and what I had heard about egg tempera paints. It then occurred to me that

while water was the apparent paint-making liquid to my modern American sensibilities, it may not be the case for everyone, especially not in the past.

Inspired by this realization, I came up with my main research question: What were likely binders that early Californians/humans/hominins used with red ochre as a pigment? It started out being specific (Californians) and then got broader and broader as I realized the modern limitations in procuring materials and the more widespread use of ochre as evidenced through greater research.

Within this main research question I have seven major sub-questions:

(1) How did binders affect the paint's aesthetic properties? I.e. which binders made paints that were nicer looking, shinier when dry, deeper in color, etc?
(2) How did the binder affect the ease and workability of the paint? I.e. viscosity, tendency to fall out of solution, texture, etc. How difficult was it to get the ochre and binder to mix/stay mixed?
(3) Which paint stayed better once applied to the rock's surface and allowed to dry?

(4) Which binders made the paint keep longer without needing to be reconstituted? How long did it take for each paint to dry out?
(5) Which binders made paints that were easiest to reconstitute after they had dried out?
(6) How much time (in minutes if possible) was spent processing the binder before it could be successfully mixed with the ochre?
(7)How difficult was it to obtain the binder initially? I.e. does it only occur in

a very specific time/place? Would it need to be carried/prepared especially for this purpose?

Other questions that would enlarge the scope of the project but add nicely to the research are as follows; the extra resources required are in brackets:

(8) Does the application method (finger, stick, brush, leaf, etc.) lend itself to using certain binders? [applicators, more rock surface area]

(9) Do any of the paints created emit fumes? [a not well ventilated area]

(10)How does rock type affect durability? [multiple rocks of differing types]

(11) How does rock type affect painting experience? [multiple rocks of differing types]

(12) Does humidity have an effect on the longevity of the image? [twice as much of everything]

(13) Does the ratio of ochre to binder affect the other variables mentioned? [more: surface area, time, containers, red ochre, and binders]

(14)Can the painted image be removed from the stone? (Before/After it has dried, and via friction or solvent use?) [at least twice as much of everything, depending on how many extra variables are tested]

(15)What happens if you mix more than one binder or more than one paint? [more: containers, rock surface area, binders, ochre]

After one knows what they will be looking for in their results, they can compile a list of materials and lay out the experiment. The experiment itself is very simple and is composed of only 5 basic steps, which are as follows:

1. Gather Materials.
2. Place Ochre in Each Labeled Container.
3. Add Binders to Pigment.
4. Mix Well.
5. Paint Rock.

Suggested Materials include but are not limited to: oils (as many different types as practical), grease, lard (animal fat), gelatin, water, sea water, saliva (both plain and after chewing pumpkin seeds), urine (possibly animal), blood, bone marrow, semen, egg (as many types as possible; both separated into white and yolk, and mixed), raw milk (cow and goat varieties, if possible), beer (and other alcoholic beverages/fermented plant-matter), various Juices (natural, perishable/fresh, fruit and vegetable varieties), honey, wax (beeswax), pine pitch (and other types of sap/gum/syrup), powdered red ochre (rock-form if you must insist), a large untreated relatively regular stone surface (preferably smooth), separate and adequately sized labeled plastic or ceramic containers (semi-disposable and with lids as some of these paints are perishable and will smell bad), applicators (fingers, sticks, brushes, leaves, rocks, feathers, whiskers, quills, reeds, or anything else one might use to paint with), note-taking materials (pen and paper), stop watch (for measuring prep time), measuring devices (to standardize ochre/binder ratios if you wish, or at the very least a spoon), and a camera. A sink, hand towel, and dish soap are also useful in moving from one binder to another during the course of the experiment if you are using your fingers to paint.

In order to create a complete and accurate guide by which to generate a system for evaluating paint production, I recommend that another, one-time study is conducted in which one grinds ochre to powdered form from rock, noting the time and energy required, and the volume produced. It is likely that one would get more proficient at grinding ochre the more they did it, but it is also likely that there is a lower limit on how long it might take. As I'm sure there are various ways to pulverize iron ore, and I'm more concerned with the obtaining and treatment of the *binders* than the ochre, I'll leave the methodology and particulars of that experiment to someone else.

In a similar vein, I propose that in the case of the binders that are specially prepared (oils extracted from seeds, sap collected from trees, bone marrow, etc.), experiments in which one goes out and collects the materials for making these binders and then processes the raw materials into proper binder should also be conducted. The time, effort, and exertion should be recorded; along with other important factors such as if it is possible to use leftovers from other processes that would have been carried out for other reasons (i.e. bones from food, oils that have other common uses, waste from a certain type of processing, etc.). It would then be possible to rate the paints based on time it would take to make them from scratch, with separate versions for items that would have been readily (or semi-readily) available around camp for other reasons. Time to locate the material (and if it is seasonal) should also be taken into account, although it may be impossible to get accurate ideas of how long foraging for certain materials would have taken in prehistoric locales.

In order to do this properly, one needs to standardize a few aspects of the endeavor: the amount of ochre used in each paint, the amount of binder used in each paint, the

amount of paint that goes onto the rock face (either by holding constant the amount of times you dip your applicator in the pot or by counting how many dips it takes to fill a certain sized area or create a certain consistent shape). You should also strive to use each paint within a regular time window from when you mixed it to when you apply it. Another important consideration is that some of the paints may have binders that leach outward and spread over the surface of the rock. Be sure to leave space around each painted area to help mitigate the effects that may have. Also, if the rock you are using will need to be transported at some point in time, it would be advantageous to avoid painting on areas that will be handled during its transport, as the paint may rub off prematurely during this process.

The results section would be very long and involved, including charts and tables and plenty of words and description. I would expect one section of the results to go through binder by binder and describe what it was like preparing, measuring, mixing and painting with it. There should also be discussion of the drying process and any changes that have occurred over time at the time of writing. This section should contain the answer to the question: Did the paints become *of the rock* or did they remain *on the rock*? (Chippendale and Taçon 1999:103) And there should be in depth visual analysis of the paint in the container over time. This should cover details such as how long it took to dry out completely, did the color change and how, and a description of any smell that may have appeared or disappeared over time.

After an initial descriptive section, there should also be overall impressions and general trends that the researcher noticed during the course of the experiment. There

should be comparisons made between specific paints, and one should devise a series of scales on which the paints are rated and assigned locations in a hierarchy. For example, one should have a list based on intensity of color, drying time (of both rock and container paint), the level of incorporation into the rock face, remaining true to the color of the initial powder (for example if it got lighter/darker/yellower/pinker/browner), ease of application, going the furthest (using the least amount of paint to cover the most surface area), mixing the quickest, remaining where it was put, and the level of bleeding that occurs after application (oil based paints do this). Once these lists are created, one can apply the principles of Optimal Foraging Theory(that actors will attempt to get the highest quality and quantity of suitable available substances for the least amount of energy), and discover which paints would have been both the easiest and the costliest to make.

This process is important as it will help to shed light on the usage of different binders in context. It may turn out that binders such as blood that are often thought to be loaded with meaning may also turn out to be the most economic to use. Researchers like to speculate on why our ancestors used what they used how they used it, and this would help to reveal the relative ease of certain ancient choices, allowing for claims of 'because it's simpler' or that because it is labor intensive, there must be a reasoning behind it (whether it be because it is meaningful or because it produces a specific result that cannot be reached by less exertion).

The researcher should then assess the different paints on the basis of whether or not they would be able to be created on site, or if the painter would have to bring them in pre-mixed. If they would have to bring the materials and mix them on site, questions of

feasibility for each binder should come into play. In locations that are difficult to access or have little space or light in which to prepare paint, is it feasible? Does this remain so if the paint has a strong odor? They should also suggest that people hoping to use their research to further their own claims take these questions into account as well in the specific context they're framing it in. For example, what happens in situations where the group in question used stationary, non-mobile mortars? What if it is a society where women have the traditional role of grinding? Especially if the subject of the paintings reflects symbols associated with femininity? Considerations of binder preparation could theoretically completely overturn claims that rock painting was a male-dominated activity. These are just a few examples of how more in depth studies of binders can potentially contribute to broader archaeological questions. Once an experiment like the one proposed here has been conducted, it will be possible to answer some of these questions, speculate on others, and come up with more that are yet unanswerable. Still, even without running an experiment as sophisticated and time intensive as the one suggested, knowledge can be gathered from thoughtful reflection on both smaller studies and the previous work of others.

GENERAL IMPLICATIONS AND CONCLUSIONS

Why should we worry about what binders were used? Why should we care about binder preference and selection? What can be learned from this? Why is this thesis necessary? The answers to these questions, while simple, may not be terribly obvious. Binders are just as important as the pigments used by hominins. Without them, in most cases, there would be no rock art for us to find. Our ancient relatives would not have been able to partake in this particular vein of artistic expression. There would be no evidence for archaeologists and art historians to look at to help shed light on ancient desires, capabilities, or thought patterns. Rock painting would not exist. Red ochre has been important in areas outside of rock painting as well. Ochre is an important aspect of many ritual behaviors, has been used in social cohesion and identity forming, and has persisted as a pigment used by peoples on all continents for hundreds of thousands of years.

Binder preference and selection is just as important as the actual binders themselves. They help answer questions such as how important these sites were to their creators. I do not pretend that we can ever know how much a painting meant to its maker, but I will argue that you can make a case that it was relatively important if they were using a binder in a form that's not edible or obviously medicinal (and possibly commonly prepared for that reason). It is not possible to say that because a lot of extra work did not go into binders that they (or the artworks they helped create) were not important, but it is possible to say that based on the extent to which one went out of one's way to create the

paints (if it can be reasonably believed that it was somewhat of a hardship), that these were important to those that begot them. We will never know why for sure, but it is definitely an aspect of human evolution and behavior that modern people find compelling; so, if we are going to be speculating about it anyway, we should have as much information at our disposal as possible.

I propose that in cases where there is a rather intact archaeological record, it should be possible to discern whether binder preparation and selection was based more on convenience or more on some other form of preference. This would be most obvious if the two were mutually exclusive, but with a well preserved record, one should be able to find evidence of binder preparation or use either way. One would expect that if ancient peoples were using binders that were otherwise byproducts of their everyday life, that this binder production would not look particularly spectacular or unusual in the archaeological record. It would look rather similar to an assemblage for a group that did not create paint, with the exception that one would anticipate further or a greater amount of processing and extraction going into the areas that created certain preferred binders.

If the group was going out of their way to collect and create binders, one would anticipate finding either a much greater quantity of binder-creating raw materials in the record or evidence of binder preparation that was unlinked to food or other subsistence production. In addition to this, depending on the locale in which they painted, either sites near rock paintings where paints were processed or containers for storing and transporting the necessary materials. In the case that everyday activities were being used to create binders, one would anticipate seeing evidence of either habitation sites being near

rock painting sites or like the other group, containers for collecting and transporting excess binders or premixed paints.

Through writing this I learned a number of important lessons. For one, it does not take a specially trained person to create and conduct an experiment that could potentially open a new avenue of study in a discipline. It is possible for one experimenter with a reasonably intelligent idea and the capacity to describe their experiences to contribute to the knowledge base of present humanity. I also learned that homemade oil and egg paints are not as glamorous as they sound, and that something as simple as sugar water can turn out to be exactly what was desired. I find that when I consider this I'm surprised that oils, fats, and water were such common binders across the record. Fats and water could be the product of lazy paint-makers (using materials that they already had access to), but I am not sure that one could say the same thing about oils, which require extraction. Still, with my first choice being sugar-water, I should note that in the cases where sugar-water was used as a paint base, it was a labor intensive process taking over 24 hours (Chippendale 2007). It is completely possible that it is less work to extract oil, and that is why it is more common than what I perceive to be the more pleasant paint, but that is not something that will be known before further research has been conducted in that vein.

The purpose of this piece is not to simply review the literature, complain about obvious deficiencies that were evident, or overemphasize the importance of binders in archaeological contexts. It is instead an attempt to add to the literature, highlighting areas that could use more research and/or consideration, and to note that these aspects of rock art that have yet to be fully explored are not irrelevant, unnecessary, difficult to study, or

obscure, but simply another avenue for considering aspects of research that have been repeatedly ignored by most fields of study. I am advocating for the use of experimental archaeology among other creative methods of study that add new perspectives and information to the collective pool of knowledge. I also encourage the incorporation of more avenues of theory into the archaeological discourse. But most importantly, I urge those who are predisposed and have the means to undertake some form of project that would be useful to others and that will allow future scholars to build on their work. All it takes is one person asking the right questions. I do not presume that the questions I have posed here (about binder selection) are those questions necessarily, but I would say that since there has historically been speculation about meaning being attributed to binder selection, it is just as important to consider that it is possible our ancestors were just lazy and found creative ways to work around that.

Binder selection is important in the context of understanding rock painting. Rock painting has the distinction of being some of the oldest material culture left behind by *H. erectus, H. ergaster, H. habilis, H. heidelbergensis, H. neanderthalensis,* and even *H. sapiens.* Red ochre is important as a pigment in these ancient sites, and signifies more than just a simplistic means to an abstract end. It is evidence that hominins began to think of more than subsistence and survival, as the drive to make "art" is something beyond daily needs. In looking at red ochre use and collection over time, we are able to study ourselves through the filter of the past. There is no better way to glean this information. This is beyond a few anthropologists studying one site to learn about a specific group of people that lived in a

certain place at a certain time; this is of a much larger scale. This is about understanding all humans and our close but extinct relatives. This is about humanity.

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