A COMMUNITY OF PRACTICE IN OBSDIAN STUDIES

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Abstract

This project report describes several aspects of an effort to initiate a productive practice in obsidian studies within the Anthropology Department at San Jose State University. This effort, a resurrection of the previously vigorous obsidian studies in the Department from the 1980s through the early 2000s, is situation within the theoretical framework of "communities of practice" as first described by Lave and Wenger in the 1980s. This broad project proceeds from the initial step of acquiring technical competency in obsidian hydration as an archaeological laboratory technique. I then use new knowledge of obsidian hydration to conduct new original research in California prehistory at an important Middle Holocene site on California's North Central Coast, CA-SCR-7, aka Sand Hill Bluff. Finally, I propose collaboration with the local Native American community that will further integrate the native perspective in the community of practice in obsidian hydration at San Jose State. It is argued that such an approach will engage the transformative potential of communities of practice forwarded by DePalma (2009) to the betterment of all participants in the practice community.

ACKNOWLEDGEMENTS

I have many people to thank for their guidance regarding my graduate project. I need first to thank Dustin McKenzie, Cabrillo College, for encouraging me to apply for the 2009 Bennyhoff Award and for being my faculty sponsor. I also must thank the Society for California Archaeology 2009 Bennyhoff Committee for selecting our application. The award opened many important opportunities for me, none more important than meeting Tom Origer and Janine Loyd of Tom Origer and Associates. Tom taught me obsidian hydration and will always be my mentor.

My experience resurrecting the San Jose State Obsidian Laboratory (SJSUOL) was a success due to the support of Dr. Meniketti and Alan Leventhal. Dr. Meniketti made the project possible by committing himself and the Anthropology Department to supporting my efforts and by giving me the freedom to proceed at my own initiative. Alan said yes to every request I had regarding the SJSUOL. I am also grateful to Mark Hylkema for his personal and professional encouragement.

It was an honor to work with the cultural material from the Muwekma Ohlone traditional territory, and I thank Muwekma Ohlone Tribe of the San Francisco Bay Area for that privilege.

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Introduction

From the 1980s through the early 2000s, the Anthropology Department at San Jose State University was in the forefront of promoting obsidian hydration as a laboratory method in archaeology. Laboratory methods classes at the time exposed students to the theory and method of the hydration technique and provided the opportunity for students to work with real archaeological obsidian. Eventually, a practice developed and the laboratory began generating hydration readings for the archaeological record. The lab was so prolific that a compendium of hydration readings from the lab (Wilson 2005) was published through Coyote Press, a noted purveyor of California archaeological literature.

Within the two years from 2005 to 2007, however, the hydration laboratory lost both Professor Tom Layton and long-time volunteer laboratory technician Glen Wilson to retirement. Both were integral to the continuing operation of the lab. These events also coincided with a downturn in the interest in obsidian hydration within the archaeological community (Origer 2010). Hence, interest in the technique within the lab and department diminished markedly. At the time I joined the Anthropology Department's Master's of Arts program in 2009, the once active obsidian lab had been essentially dormant for three years.

In discussing this situation with Dr. Marco Meniketti and Department Chair Dr. Chuck Darrah, it became clear that a graduate project to learn hydration and resurrect the lab would be well received. The idea held promise for current and future students and, when completed, would enhance the Department by reclaiming a past technical capacity within the anthropology laboratory. With these goals in mind, I began the resurrection of the hydration laboratory, hereinafter referred to as the San Jose State University Obsidian Laboratory (SJSUOL), which eventually grew into the three-part MA project presented below.

Community of Practice

As I worked through the project, I began to consider the decline of the hydration lab in 2007 as an analytical problem in the larger context of applied anthropology. Had the practice of obsidian hydration at the lab really depended on two people? What methods were used to generate continuing student interest in the lab? Most importantly, was there an organizational model that would make the practice, once re-established, more resilient in the future?

Regarding these questions, the concept of "communities of practice," strongly associated with the work of Jean Lave and Etienne Wenger (Lave and Wenger 1991) has been fruitful. First associated with the analysis of professional learning and knowledge development, communities of practice has become more broadly applied to mean "…group(s) of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (Wenger, McDermott and Snyder 2002, 4)." Communities of practice exist at the intersection of three elements: a "domain of knowledge," a "community of people" involved with the domain, and a “shared practice” that the community develops within the domain. Another key feature of the concept includes that members of communities of practice self-select based on passion for the subject and expertise they either have or want to develop within the domain of knowledge. Critically, the longevity of the community is connected to the cohesive effects of shared passion and expertise in the community and the ongoing relevance of the practice to community members as a source of collective learning (Wenger, McDermott and Snyder 2002).

In the context of the previous hydration lab operation, it seems likely that all of the elements for a community of practice existed adequately to account for many years of success. It might be concluded that the previous lab operation progressed through the first four stages of the five-stage life cycle of a community of practice as described by Wenger, McDermott and Snyder (2002). These stages are (1) *potential* (coming together of people with shared interests), (2) *coalescing* (implementing ideas and activities), (3) *maturing* (clarifying standards and goals in continued practice), (4) *stewardship* (sustaining established activities), and (5) *transformation* (transforming the community in reaction to changing conditions). Transformations can be numerous and varied and include changing roles of individuals, loss of individuals and the inclusion of others, new goals and directions from within and outside the community, and many others. Outcomes from transformative periods can range from renewal and rebirth of communities of practice to reduced interest and relevancy leading to discontinuation of the practice community (Barrett, et al. 2009). Unable to renew itself at the time, the hydration lab contracted into a dormant period.

Fortunately, the larger structure of the Anthropology Laboratory insulated the fallow hydration component from complete abandonment. This structure, which also supports general lab classes, student projects, and faculty research in such subfields as osteology, skeletal pathology, and pottery analysis, was critical to the success of the present project. The accumulated hydration literature in the lab, for example, was retained in the lab’s library, and the hydration equipment, though unused, was safely stored rather than discarded.

Moving forward, it seems logical to start from the beginning with a new comprehensive model for ongoing operations. I suggest here that such a model should be based on developing a community of practice with the capacity grow, mature, and sustain continued practice in obsidian studies at the SJSUOL. Most importantly however, the community of practice must have the resiliency to overcome transformative challenges in the future.

The model below (Figure 1) is a description of the major elements and connections within the SJSUOL community of practice. The model helps to illustration the present project but will also serve for further consideration in the development of the organization as well as be a problem solving for organizational issues. The model is intend to provide the a strong foundation for the future.

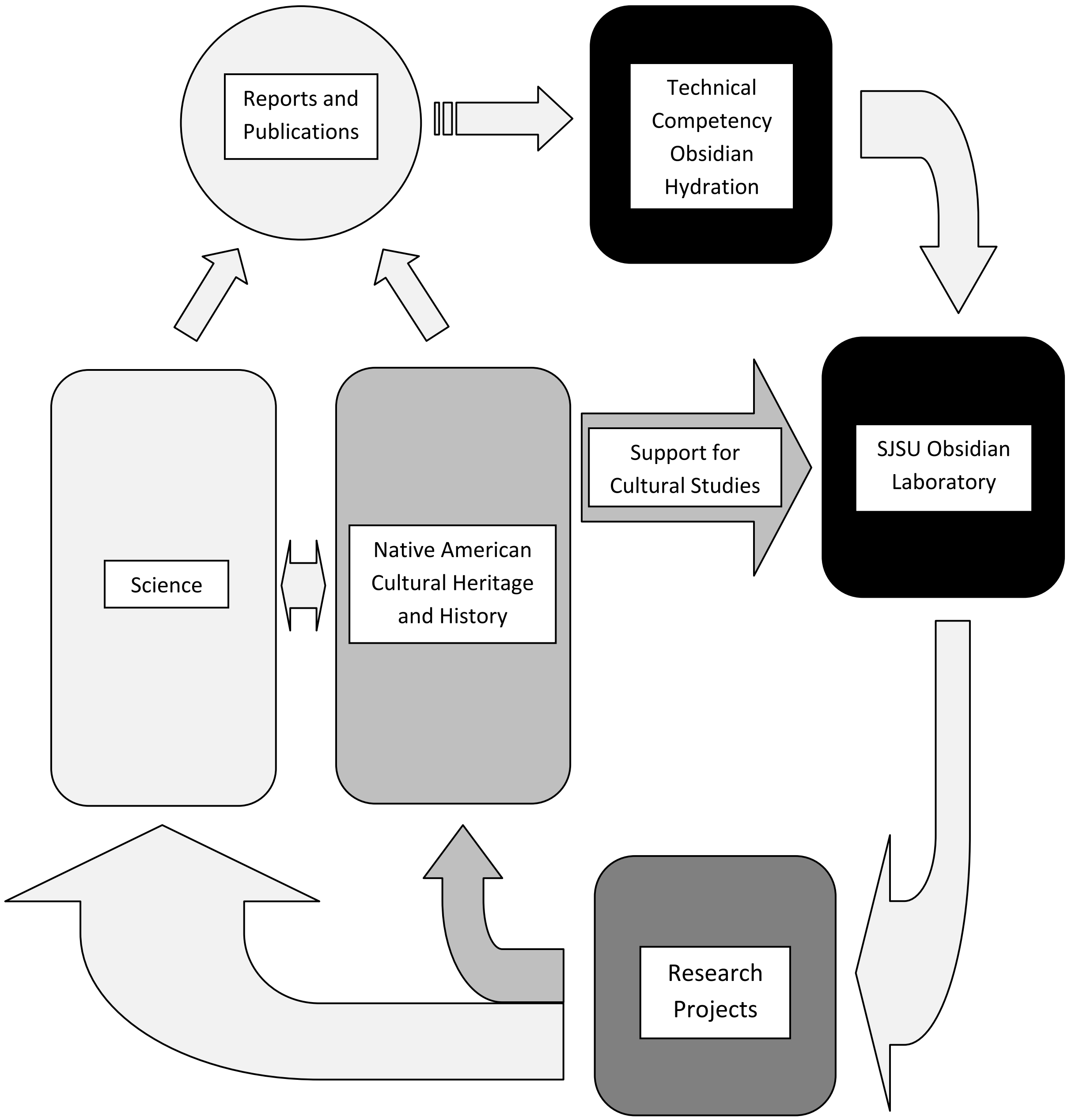


Figure 1: Community of Practice: Framework for a Three-Part Project

- Part I: Obsidian hydration training and resurrection of SJSU Hydration Laboratory
- Part II: Research project—Obsidian Trade at Sand Hill Bluff
- Part III: Proposal—SJSUOL/Muwekma Ohlone Cultural Exchange Collaboration
- Elements common to all parts of the project

A Project in Three Parts

The diagram also indicates how the various parts of my MA project intersect with the broad vision for building a community of practice in obsidian studies; that is, each part is linked with or supports particular elements of the model. Part I (shown in black) is associated with technical competency in obsidian hydration and the SJSUOL itself. This can be considered the first occurrence, or the regenerative stage, of these two elements. Part II (shown in dark grey) is a research project completed through the revived resources of the SJSUOL—the first new research conducted in the lab for several years. Part III (shown in light grey) is a proposal to broaden and fortify the organizational foundation of the community of practice in obsidian studies for the future.

As described in Part I of the project, I acquired technical competency in obsidian hydration through an apprentice-mentor relationship with Tom Origer at the Origer Obsidian Lab (OOL) in Sonoma, CA. With this new knowledge, I reorganized the SJSUOL and returned it to operational condition. In recognition of the fact that future students will also need such competency, the Part I report includes a description of the optimal path to competency based on my training experience. The report also includes an extensive literature review of the theory and method of obsidian hydration to support student learning. Part I concludes with a concise lab manual for the basic procedures required for the professional operation of the SJSUOL. Much of the information contained in Part I is summarized in a one-hour introductory lecture on obsidian hydration intended to interest new cohorts of students in the SJSUOL. This lecture is attached as Appendix A.

The second part of the project is a traditional archaeology research project, *Obsidian Trade at Sand Hill Bluff*, funded by the Society for California Archaeology's 2009 James A. Bennyhoff Memorial Fund Award. Receiving this award led directly to my interest in obsidian hydration, and a large portion of the obsidian hydration work for this project was done in the SJSUOL. This research is one example of the many undertakings students can accomplish via the SJSUOL community of practice.

Finally, Part III is a proposed project to strengthen communication and support between the SJSUOL and the local Native American community, represented in this context by the Muwekma Ohlone Tribe of the San Francisco Bay Area. The Tribe is a formerly federally recognized group whose members trace their ancestry to aboriginal peoples of the greater San Francisco Bay region. The proposal, *SJSUOL/Mawekma Ohlone Cultural Exchange Collaboration*, involves a two-way transfer of knowledge that will be undertaken graduate student at some time in the near future.

As envisioned, student technicians would communicate obsidian research findings related to Muwekma Ohlone cultural history, providing the Tribe with a tangible benefit from the analysis of their cultural material. In the reverse direction, collaborative research with the Tribe will transfer indigenous knowledge needed to create a new cultural depth for obsidian studies in the SJSUOL. Such information might include contemporary Native American perspectives on laboratory methods, obsidian objects as cultural patrimony, and how the Tribe's traditional Muwekma Ohlone language might be expanded with new words and phrases to make SJSUOL research results and presentations more ethnically informed and locally relevant. While the proposal will have to be adapted to specific circumstances in the future, the main goal is to further integrate the contemporary Native Americans community in the SJSUOL community of practice.

Part I: Technical Competency and Resurrection of the San Jose State Obsidian Laboratory

Introduction

Part I is intended to support the development of a community of practice at the SJSUOL by supporting student learning and providing specific direction for laboratory operations. The information reported here is based on my training experience as an apprentice to Tom Origer, an experience hydration technician.

Part I begins with a chronological description of the learning process. The information is a combination of ethnographic style reporting and technical information from secondary sources. The most appropriate use of this section would be for students to study it before and during their own learning process with an experienced mentor.

Following the description of my learning process, I summarize the optimal learning process in terms of the basic subtasks of the hydration process. The description includes reasonable time expectations for learning these specific tasks. Students might use this information to gain perspective on their learning and to judge their progress.

Part I concludes with a procedures manual for laboratory operations. This tool will assist SJSUOL student technicians with the task of standardizing key laboratory procedures and administrative functions. The manual, which can be expanded as new methods and protocols are developed, supports consistency and professionalism in the SJSUOL.

The Hydration Technique—Reporting a Process

My training began at the Origer Obsidian Laboratory (OOL) with introductions to the staff of and a brief review of the history of the laboratory. Through the OOL, Tom Origer continues a tradition of obsidian studies that for years was associated with Sonoma State University (SSU). Following the discontinuation of the lab at SSU in 2002, OOL became part of Tom Origer and Associates, a private cultural resource management (CRM) firm managed by Tom Origer and Janine Loyd. Tom Origer has taught classes in archaeology at SSU and Santa Rosa Community Collage and trained many people in obsidian hydration on an individual basis. Unless otherwise cited to another source, all the information in Part I below is attributed to Tom Origer.

Given that the subject of obsidian hydration was totally new to me, the training began with the basics. Unlike a structured class that might have began with a theoretical review of the subject, the mentor-apprentice model we were to use involved a different approach. The training began with the most practical considerations and the theoretical background would be introduced throughout the process of learning the technique.

The first topic we covered was the basics of flint knapping, or how stone tools are made from raw materials such as obsidian. In general terms, this involves what tool makers strive to accomplish, how they actually removed flakes to create edges, and what properties of obsidian favors its use for tool making.

I retrieved 40 obsidian flakes of various shapes and sizes from a collection of archaeological obsidian from a site in Sonoma County. All of the flakes were debitage, or the waste flakes from the tool-making process. As instructed, I made a visual image of the specimens laid out in size order on the office photocopier. This provides a very low cost visual inventory of the flakes for future reference. The photocopy also highlights interesting surface features that add to the information about each specimen. Technicians might use such images to discuss where to cut a piece of obsidian to remove a thin section sample for hydration analysis.

After discussing the 40 obsidian flakes with Origer in some detail, it was clear that selecting the best location to cut a particular piece of obsidian for analysis was a complex decision. In part, the decision depends on such considerations as the thickness, shape, and surface texture of any given piece of obsidian. Other perimeters for cut locations include the angles created by flake scars, visible fractures within the flake, and whether or not there is any remnant cortex (the original geologic exterior of an obsidian deposit) on the flake.

While debitage is abundant in archaeological sites and frequently represents the majority of the obsidian in a hydration study, actual tools are also cut for analysis. One of the major points of understanding regarding how precisely to cut an obsidian tool is that surface features can be generational; that is, they may not have created at the same time, such as when a knife blade is resharpened only by removing small flakes on the cutting edge. This is important because if this is the case with a particular tool various part of the tool will contain different hydration data that relates to different tool making, and therefore cultural, events. The surface of a large flake, for example, may consist mostly of the original flake margin created at the time the piece was removed from the quarry or a larger piece of obsidian and have smaller younger flake scars from human modification. The time lapse between the large margin and the small margins may be considerable. Hydration readings from both surfaces should reflect this difference in time. More finished tools may also have surfaces created in more than one event of human modification. In most cases however, it has been found that all margins of finished tools have little or no difference in hydration between margins, indicating that the tool was made in one event of production. Each specimen is in this way unique. By surveying the specimen carefully, technicians can select cut locations from the margin(s) that will most likely yield important and interesting data on the temporal characteristics of a given obsidian object.

It is a comment on the esoteric nature of obsidian studies, as well as budget considerations, that most CRM clients that send specimens to OOL are not aware of or do not care about the potential for the level of temporal detail noted above. Usually, the client is only interested in basic information regarding when people *most recently* used the tool, since this will typically be sufficient to date a site and meet minimum standards of compliance with cultural resource regulations. Unfortunately, this leads to a bias toward the removal of thin sections from the “cutting edge” of obsidian tools and flakes, where presumably the need to resharpen the tool through removal of small pressure flakes was the last human modification. From a scientific point of view, reconciling what really *should be studied* to find out the most information about a particular piece of obsidian with what typically *is studied* in CRM archaeology is an ongoing issue.

Technicians should avoid cutting into original cortex and badly weathered surfaces because they do not produce thin section with readable hydration bands. As Origer stated, "Those margins do hydrate, but they will be all goofy and hard to read. Nobody wants to know the hydration reading of the cortex." A flaked surface with a smooth, flat, non-weathered surface is therefore a practical requirement for obsidian hydration to produce usable data.

Regarding the geologic fundamentals of obsidian, I found two helpful sources. The first is a general text on physical geography with a chapter dedicated to the formation processes of igneous rocks (Monroe and Wicander 2001). The second was a compilation of obsidian-centered studies from both a geologic and archaeological perspective (Shackley 2005). While the case studies in the book provide examples of the variety of approaches to modern obsidian studies, my interest was particular to the excellent introduction to the unique properties of obsidian that make it such an appropriate material for geochemical sourcing and hydration analysis.

Essentially, obsidian forms when high silica magma extrudes or nearly extrudes during periods of volcanic activity. The magma finds paths to the surface through existing rock that imparts particular trace elements and minerals that later serve to identify the obsidian. Obsidian is exceptionally homogeneous within one source largely because extrusive action is characterized by short punctuated events during which the chemical composition of the magma and the rock matrix through which it passes remain constant. Rapid cooling at the surface also contributes to the lack of intra-source variation, as there is little time for newly extruded material to mix with other material at the surface (Monroe and Wicander 2001). This formation process creates a geochemical signature that can be “read” by any number of techniques regularly employed in the field of geology (Shackley 2005).

The use of the gem saw was the next training topic. Essentially, the gem saw is a small table saw with a very thin blade covered in diamond fragments as the “teeth” that forge through material. Unlike a wood saw, heat and friction created when cutting stone with a diamond blade requires the blade remain lubricated with water or oil during operation[1]. For the saw used at OOL and SJSUOL, the blade remains immersed in water to disperse heat. The amount of water is critical, and the blade should remain just under the surface of the water in the reservoir. This allows the blade to remain wet without throwing excess water onto the material being cut during operation.

The technique of cutting obsidian is a skill that takes time to master. Each thin section removal requires two cuts into the obsidian that are parallel to each other and perpendicular to the surface of the specimen.

There are two primary considerations regarding the actual cut into the material. First, cut depth is how far into the obsidian a technician leads the saw blade. Ideally, technicians should cut as shallow as possible and still be able to extract the thin section. Shallower cuts minimize the aesthetic degradation of the artifact and reduce the surface area of the thin section, which in turn reduces grinding time. Unless the sample is particularly small, the target depth is approximately 3/16 inches, or 4 to 5 mm. It is not necessary for the two cuts to be exactly the same depth; having one cut slightly deeper makes the thin section easier to remove. Second, the distance between the two parallel cuts, which determines initial thinness of the thin section, is also important. These two cuts should be about 1/16 inches, or 1 to 2 mm apart. This makes the thin section thick enough not to break off during the cutting process and thin enough so it does not require excessive grinding, which is time consuming.

My practice with the gem saw went very well. Any previous experience with a table saw will make learning this skill easier. Even with some experience, making good clean cuts takes practice. However, students can expect to improve quickly. Holding the obsidian is a part of the process that involves some “touch and feel” to insure the blade works properly in the obsidian. Upon initial contact of the blade with the material, the blade takes a second to stabilize. It helps to allow the blade to do this with a slight pause in the motion of the material toward the blade. After the blade stabilizes, it will “take” the material with the slight attractive force created by the rapid rotation of the blade. This produces a cleaner cut. Some micro flaking occurs where the blade exits the obsidian even with a stabilized blade and steady hand, but the minute flake scars created by this do not affect the process.

To remove the thin section, the technician inserts a razor blade into the shallower of the two parallel cuts. Light pressure applied in the direction of the other cut will cause the thin section to break off at the base. The technician then removes the thin section by hand to a clean, preferably light colored, staging surface.

Two readings supported this initial training. The first was a portion of Glen Wilson's unpublished autobiography that explained briefly his training in obsidian hydration with Tom Origer in the 1980s. Specifically, Wilson noted that it took approximately one year to gain complete confidence to work independently with the entire hydration process (Wilson 1995). This feedback from a then relatively inexperienced technician was reassuring about my own training. New students should not expect to obtain proficiency with the hydration method quickly or without considerable effort and practice.

The second reading was Tom Origer's article analyzing Ishi's debitage that accumulated during his famous stay at the Anthropology Museum in San Francisco in the early 20th century. The article documented the initiation of the hydration process in very recently knapped obsidian since hydration readings from the flakes correlated well with the narrow window of time (1911-1916) during which Ishi made stone tools at the museum. This type of analysis is strong evidence for the validity of obsidian hydration as a temporal control. Prior to this study, researchers had few examples of young hydration bands of less than one micron (Origer 1989). Other hydration studies in very late contexts have continued to refine understanding of the "first micron" of hydration development (Sillman 2005), adding greatly to the usefulness of obsidian hydration in historical archaeology. Following this thread in the literature, I also found an article on the stylistic and technological aspects of Ishi's tools (Shackley 2001). The background information in this article put hydration information from Origer's study in a broader context.

Instruction moved forward to the preparation of permanent thin section slides. This portion of the hydration technique is no more high tech than cutting the samples. Thermal plastic (Lakeside Cement) is melted on a standard microscope slide with the use of a hot plate. Melting the cement without burning it takes practice. If it becomes too hot and starts to bubble aggressively and smoke, it will turn brittle in the solid state, potentially reducing the durability of the slide.

The technician then places the thin section into the liquefied material, pressing it firmly against the slide to force the liquid cement from between the slide and the thin section. After a few seconds, the liquid cement hardens, holding the thin section firmly in place.

At this point technicians grind down the thin section with 600-grit abrasive powder and water on a glass plate. After grinding one side of the obsidian thin section to just over one-half of its thickness, the cement is heated and liquefied again, permitting the technician to invert the thin section on the slide. Again, the thin section must be pressed firmly against the slide before it completely cools. The second side is similarly ground until the thin section is about 0.003 inches thick. There is an instrument at the SJSU anthropology lab that can measure this thickness in inches, but experienced technicians can feel the correct thickness by passing a finger over the surface of the mounted obsidian.

The amount of water on the plate is critical to facilitate the grinding process. The grit “mud” should be about the consistency of thick gravy or wet toothpaste. After grinding, the slides are rinsed thoroughly with water and dried. The final step in the slide making process is placement of a glass slide cover over the thin section and the hardened mounting cement with a drop of permanent glue.

In preparation for further training, I read the foundational work in hydration technique by Friedman and Smith, *A New Dating Method Using Obsidian* (1960). This article describes the early understanding of obsidian hydration by geologists as a diffusion reaction. The article also describes the method of making thin section slides to make hydration readings—a process that has changed little in the intervening years. Friedman and Smith were the first to advocate the use of obsidian hydration as a dating method in archaeology. The authors explain how geologists discovered obsidian hydration as they studied the various properties of volcanic glass from around the world. They noted the correlation between the hydration band growth and time as well as the association of obsidian with perlite, the amorphous volcanic glass with high water content (3.5 percent) that forms through the hydration of obsidian. Perlite is the hydrated portion of obsidian that spalls from non-hydrated obsidian (0.1 to 3.3 percent water) when the hydration band approaches 40-60 microns (Friedman and Smith 1960).

While other researchers have proposed other models to explain the hydration process, the diffusion reaction model has remained in common use.

Also of great interest is Jonathon Ericson's 1977 dissertation, *Prehistoric Exchange Systems in California: the Results of Obsidian Dating and Tracing*. Ericson evaluated the "fit" of archaeological data from fourteen source specific collections to six different hydration models, one of which was Friedman and Smith's diffusion model. His study supported that the original diffusion model from 1960 was still the most accurate rate equation (Ericson 1978). While other researchers evaluating the same six models found reasons to suggest other models were closer to the truth about hydration (Meighan 1983), Tom Origer came to the same conclusion as Ericson in this master's thesis ten years later (Origer 1987). The diffusion model is therefore the theoretical basis for my training and the model that will be use at the SJSUOL in the future.

New technicians should understand that obsidian hydration generally and the diffusion equation specifically remains contentious. Studies have challenged the theoretical understanding of the process and the use of optical instruments to measure hydration bands, citing the use of secondary ion mass spectrometry (SIMS) that shows the hydration band to be uneven and poorly corresponded with the visual image seen in under optical magnification (Anovitz, et al. 1999). While others responded to this critique effectively (Hull 2001), anyone involved with hydration would also admit that problems regarding the predictive power of rate models remain to be resolved.

One of the main problems surrounding the theory and method is the strength of the paired associations of obsidian artifacts to radiocarbon dated organic materials from archeological contexts. These paired associations are the data that hydration model builders try to "fit" into mathematical equations, producing better or worse correlations as a test of validity. Traditionally, these associations have been rather weak.

Commenting on this matter, Origer states that strong associations, such as an obsidian point lodged in bone, are exceedingly rare. Poor associations, which have become normative as empirical evidence, is when a radiocarbon dated samples and obsidian are simply found "in the same context" without considering the potentially very different depositional realities of the pair. "The same context" for example, could still have an inter-contextual temporal range of thousands of years. Having more and better associations should improve the reliability of hydration rate models.

With some introductory experience to build from, training began on the use of the microscope to find and measure the hydration band using the same slides I had made in earlier training sessions. As a first step to viewing slides under the microscope, I drew sketches of what I was seeing—a time tested learning device for archaeology students. Drawing also helps technicians understand the "geography" of a particular thin section, because it is not possible to see the entire thin section through the microscope.

Initially, it is best to survey the entire rim of a thin section with relatively low magnification (100X) before trying to find the hydration band in one particular spot with high magnification (400X). Surveying the entire sample makes it easier to find readable locations quickly, rather than becoming frustrated trying to find the band in a particularly difficult location.

Obsidian shows great detail under magnification, with its own kind of beauty in the shapes, coloring, and subtle imperfections of the glass. The color variation between thin sections is truly amazing, ranging from dark, almost opaque, brown with multicolored crystals to a translucent blue-gray with very small black linear shapes that look like cells or some other biological organisms. In fact, they are tiny fragments of minerals like iron.

It was obvious that I had ground some of the thin sections too thin, which causes disintegration of the perimeter of the thin section into broken flakes. On the well-made slides, the hydration band was small and it was frustrating trying to locate the hydration band. Once the technician finds the band and brings it into good focus, he or she uses the micrometer in the eyepiece to make up to six band measurements. The final reportable hydration value for a particular thin section is the mean value of the six readings.

There are several difficulties that new students will face when making hydration readings with the microscope. The hydration band, which is also referred to as the hydration rind, has less of a contrast on dark thin sections. The lighter specimens are somewhat easier to see and the blue filter works well to amplify contrast on these colors. For this reason, it is tempting to use the blue filter when making micron readings.

Unfortunately, the blue filter also causes most technicians to read the band as too large and should only be used for finding the hydration band and white light should be used for readings.

On some slides, the band is minimal because of surface imperfections such as fractures in the glass and erosion from wind and water. In such cases, technicians may find hydration on only a small percentage of the perimeter of the thin section. In this case, the number of readings may be less than six or all reading may come from a small portion of the perimeter. If no hydration band is present, no visible band (NVB) is the recorded result. Technicians may also observe diffuse hydration (DH) when the border between the hydrated and non-hydrated material, the “hydration front,” is so poorly defined that a measurement is not possible. These kinds of observations, as well as any other descriptive details of the obsidian or the measurement process, are noted and kept as part of the record of any collection under study. This reporting is done on laboratory data sheets filled out for each collection.

Another difficulty is that the edge of the thin section can at times appear as a double line. This erroneous line is called a “becke” line and it can obscure the real margins and complicate the use of the micrometer to make a precise measurements. The becke line is an optical illusion created by light passing through two materials (obsidian and the slide medium) with different refractive indexes. The false line, which is outside of the actual margin, is disregarded when making measurements.

Because of the attention to detail and the visual strain involved in working with the microscope, new students should take frequent breaks from practicing. This was by far the most difficult part of the learning process for me. When I became fatigued with the microscope practice, I found relief in the literature.

Articles that demonstrate the effective use of hydration studies to help solve real problems in archaeology were great motivators. One such article was *The Caballo Blanco Biface Cache, Mendocino County, California (CA-MEN-1608)* (Gary and Mclear-Gary 1990). As described in this article, archaeologists recovered 16 massive (17.1 cm average length, 695 g average weight) Mount Konocti obsidian bifaces in an area of less than five square meters in a vineyard in Mendocino County. The bifaces “blanks” are large ovoid-shaped, minimally reduced, pieces of obsidian of uniform size. Hydration of the blanks from this “cache” yielded a cluster of hydration readings that averaged 3.6 microns (SD = 0.55), and one outlier of 4.9 microns. Two of the artifacts did not produce readable bands. By contrast, 15 Mount Konocti obsidian flakes from chosen randomly from other parts of the site hydrated in an even distribution between 1.3 to 3.8 microns, placing the likely deposition of the cache at the beginning of the period of obsidian use at the site. The tight cluster of hydration readings suggests that the placement of the cache was a single event. This case reinforces the usefulness of hydration testing as a relative dating method—a powerful application of the technique even when there is a lack of triangulating data from other dating methods.

As another diversion from trying to find and measure hydration bands, Origer prepared a slide with a solution of plastic orbs that measure exactly 1 and 5 microns. I used the slide to verify the accuracy of the micrometer, which is something that should be done frequently. The orb slide is also excellent for practice with the micrometer. The micrometer on the OOL microscope is very accurate. I measured a 5-micron orb to exactly 21.5 ticks on the rotary scale, which corresponds to 5 microns on the slide. At this point I also began reading slides from other past OOL projects that had clear hydration bands.

The mentor-apprentice relationship with Origer for the hydration studies had other benefits as well. On several occasions, we discussed my research project at Sand Hill Bluff (CA-SCR-7) in some detail. He had been the technician for the hydration study in the original site report (Jones and Hildebrandt 1990) that was my main source of testable hypotheses as well as and the technician for the first 22 samples I had sorted from the 2008 material excavated by Cabrillo College. Regarding the work on my samples, the services provided at OOL were donated as part of the Bennyhoff Award. In order to get a bit closer to the data, I reread the 22 thin section slides as part of my microscope practice.

After six trips to Sonoma to learn the basics of hydration, I start the work of resurrecting the SJSUOL by setting up the old Olympus microscope in anthropology lab. Each microscope is a different so I had to familiarize myself with this tool. Since there was no way to calibrate the SJSUOL microscope at our lab, I took it to Sonoma, where parallel tests with the OLL microscope suggested that while the microscope worked, it was definitely worn in comparison to the OOL microscope. We tested the calibration of the micrometers in both optical objectives (10X and 12.5X magnification) that fit the SJSUOL Olympus microscope with a slide made with the plastic 1-micron and 5-micron orbs. Both micrometers have slight play in the instrumentation that causes the scale in the eyepiece to move slightly. While the 12.5X objective is still useable, the micrometer in the 10X objective is beyond its serviceable life.

The best slides at the SJSUOL for beginning microscope practice are in slide collection from CA-SON-670 at Fort Ross. This slide set has the added benefit of extensive notes in the accompanying report that provide descriptive comments on most of the thirty-four thin sections and their associated hydration bands. Laboratory comments noted for each slide, such as “band is diffused” and “great bands,” permitted me to correlate what I was seeing with the opinion of an experienced technician. This was very helpful. That the technician for these slides and notes was not Origer or Wilson added to the diversity of the knowledge during the learning process.

The lapidary saw in the SJSUOL also needed to be evaluated for continued use. Fortunately, this saw is the same make and model as the saw at OOL. It is completely adequate for use as the main saw for hydration studies. If well maintained, it should have several years of serviceability remaining. Blades are available locally.[2]

Training with Origer in Sonoma also included instruction on how to convert raw hydration values into years before present (YBP). This information is typically provided as a service of a hydration lab. There are three steps to the process.

First, the raw hydration values for different sources are temporally calibrated to a base source (such as Napa) by correcting for differential hydration rates of the various source materials. These "comparison constants" express the relationship between the hydration rates of two sources as a ratio of their respective hydration rates. The comparison constants have been experimentally derived through induced hydration tests for the North Coast range (Tremaine 1989) and some of the other major obsidian sources. For example, since obsidian from the Annadel source hydrates slower (comparison constant = 0.77) than Napa obsidian, the raw hydration readings for Annadel obsidian must be multiplied by the inverse of the comparison constant (1.3) to obtain readings equivalent to readings from Napa obsidian.

Second, the equivalent values are then adjusted for Effective Hydration Temperature (EHT). Temperature is thought to have about a 6 percent influence on hydration development per degree of divergence in EHT (Basgall 1990) from any control location (such as Santa Rosa for Napa obsidian, EHT = 16.4). To correct for EHT, an EHT value for the location of a subject site (e.g. SCR-7, Santa Cruz, EHT = 15.4) is determined and compared to the control location. These values come from a weather information website: www.wrcc.dir.edu/summary/listnca.html. Since lower temperatures *reduce* the rate of hydration and Santa Cruz is colder than Santa Rosa by 1 degree EHT, obsidian deposited in Santa Cruz will hydrate slower than obsidian deposited in Santa Rosa. Therefore, adjusting for EHT in Santa Cruz will increase the hydration readings, again making them comparable to the base source. The percent of influence of temperature is compounded by degree, not linearly. Origer developed a comparative table for EHT based on a value of 16.4 for Santa Rosa, since Napa obsidian usually serves as the base source. The table corrects the hydration readings for EHT.

The third step in the hydration dating process is the application of the hydration equation. That is, the equation that accounts for the actual physical process of obsidian hydration. While there are several models in use by various researchers (linear, exponential, etc), the original diffusion equation proposed by Friedman and Smith in 1960 remains the most reliable based on model comparison (Ericson 1978) and hydration experiments (Origer 1987).

This equation converts the adjusted hydration readings into YBP by squaring the adjusted micron reading (x) and multiplying the product by a conversion constant (k), or $YBP = kx^2$. Several researchers have defined the conversion constant during the hydration era. Origer calculated this number to be 153.4 for Napa obsidian in his master's thesis at San Francisco State (Origer 1987).

Technicians require much practice with the microscope to improve accuracy with the micrometer and to refine more general observation skills regarding the obsidian thin sections. The slides from the Fort Ross (CA-SON-670) collection are a good aid to this practice and should be used by future students for this purpose. Ultimately, a student should strive for an inter-observer error between mentor and apprentice of not more than 0.2 microns.

Inter-observer error and inter-laboratory variation in hydration results is a significant issue. In one study (Stevenson, Dinsmore and Scheetz 1988), researchers compared hydration band readings of the same specimens from five different labs and five different experienced technicians. Conclusions included that laboratory results are generally comparable, with *experienced* technicians producing measurements that fall within the optical limits of the lab equipment. Researchers reported a variance between technicians of approximately 15 percent.

Epilogue

My internship at OOL ended officially in October 2010. The total time committed to the above process was 99 hours, including nine trips to Sonoma. While I certainly was looking forward to a more independent role for the SJSUOL, I felt there was more needed from the training. As a result, trips to OOL in Sonoma have continued through the 2010-2011 academic year. Work during that period has involved learning how to make slides with very small flakes, a technique especially useful for coastal archaeology where finding minute pressure flakes is common. I also worked with Tom regarding presenting my findings and integrating them into inter-site and inter-region comparisons, the most common type of study beyond site-specific reports. Perhaps most importantly, Origer has continued to review my work for accuracy. As the mentor, he must be the one to decide when I can act independently regarding introduction of new data into the archaeological record.

Tom Origer will continue to be a great source of information and mentorship for me in the future. His collection of obsidian related literature and his personal experience make him a key mentor for any project I may undertake in the future. I am confident also that Tom will continue to support the development of hydration studies at San Jose State.

My own research has continued in the lab with more samples from SCR-7. The ability to work on these samples without having to travel to OLL in Sonoma has saved both time and money. In addition, Alan Leventhal has requested hydration analysis for specimens curated in the Department’s storage facility, some of which are owned by the Muwekma Ohone Tribe of the San Francisco Bay Area. These samples are archaeological obsidian from ongoing site investigations that may culminate in published reports. Working on such projects demonstrates the continued progress of the SJSUOL.

In April 2011, Eric Lenci, a SJSU undergraduate student in computer science and Muwekma Ohlone tribal member, became the first student other than me to express interest in learning obsidian hydration. Eric has begun training in the technique according to the model process presented above. The connection Eric represents between the SJSUOL and the local Native community has significant implications for the continuing development of an expanded and stable community of practice in obsidian studies at San Jose State University.

Optimal Path to Competency

Figure 2 is a synthesis of the process of learning the obsidian hydration technique using the mentor-apprentice model. While the subtasks can be broken down further, they represent the major functional steps of the process as described below.

Training Subtasks	Optimal Path to Competency
Qualitative evaluation of obsidian specimens to inform cut locations for thin section removal	Primary training with mentor plus several hours of initial visual inspection of both culturally modified specimens and unmodified specimens. Sketching of objects can assist understanding. Secondary source search tags: stone tools, flint knapping
Use of the gem saw; cutting the obsidian to make thin sections for viewing on microscope slides	Primary training with mentor plus at least 50 to 75 thin section extractions done in multiple sessions and setting up the saw. Supplemental training would include changing the blade and cleaning the saw. Secondary source search tags: gem saw (product information), lapidary
Making thin section microscope slides	This process actually involves several sub tasks that really cannot be separated further: mounting the thin section, grinding, and placing the slide cover. Competency will involve initial instruction plus making at least 50 to 75 slides from having the thin section to the final slide. Secondary source search tags: thin section (geology), lapidary, rock and mineral microanalysis
Use of the microscope; finding and measuring the hydration band	Primary training with mentor plus at least 20 to 30 hours of practice, or viewing and measuring at least 100 slides. Slides should have a variety of thin sections of as many different types of obsidian as possible. Students should strive for inter-observer error between student and mentor of not more than 0.2 microns.

Figure 2: Optimal Path to Competency in Obsidian Hydration

SJSUOL Laboratory Procedures

This section is a description of how the SJSUOL will function within the broader context of the Anthropology Lab, and an explanation of the data control procedures needed to operate the lab in a professional manner. In the interest of standardizing terminology, obsidian submitted for a particular project is referred to as a “collection.” Individual pieces of obsidian from a collection are termed “specimens.” Samples removed from specimens and mounted on slides are called “thin sections.”

Accepting New Obsidian Projects at SJSUOL

New obsidian projects are likely to come from one of three sources: 1) Anthropology Department faculty, 2) graduate students, and 3) outside organizations including other universities, Native American groups, government agencies, CRM firms, and private citizens. Regardless of the origin of a project, technicians should handle new projects promptly and carefully to insure that all the archaeological obsidian remains accounted for and so the laboratory is kept organized. Specifically, technicians should:

1. Assign the new project the next SJSUOL Job Number in the SJSUOL Job Log. The job number is a trinomial (SJSUOL-YY-000), where YY is the last two digits of the current year and 000 is consecutive numbers from 1 to 999. For example, the ninth project of 2011 was SJSUOL-11-009. The job log is the first section of the lab manual located on the obsidian bench.
2. Begin a SJSUOL Project Data Sheet for the project.

3. Inventory the submitted material. Count the specimens and note that and other information provided by the submitter on the Project Data Sheet.
4. Place all the material in one of the standing lab drawers in the small lab room. This room is locked and is more secure then the open section of the lab.

Working with samples in the lab

Making the Thin Section Slides

Any number of faculty, graduate students, volunteers, and classes occupy the anthropology lab throughout the year. It is necessary therefore to schedule time for hydration lab work around certain activities. Check with the Department at the beginning of each term to obtain a schedule of lab classes. Do not work in the lab when classes are in session, as certain portions of the work can be obtrusive. Hydration work is usually compatible with other lab work conducted by individuals or small groups.

When a project is ready for laboratory prep and hydration, schedule enough time to complete the cutting and slide preparation for the entire collection if possible. This is a ten-step process:

1. Organize the samples in the order they are to be prepared.
2. Weigh each sample in grams.
3. Assign a catalogue number for each specimen beginning with the number one (1). The catalogue number is the job number combined with the specimen number (e.g. SJSUOL-11-009-4). Write catalogue numbers on a Project Data Sheet in ascending order in the left column.

4. Mark one slide with each catalogue number needed for the collection. Note that to conserve space on the slide, the catalogue number is abbreviated (e.g. S-11-009-1) when it is etched onto the slide with a dremel tool. Place the job number on one line and the specimen number below the job number on a second line. The catalogue number is etched across the narrow dimension of the slide facing out, that is, away from the center of the slide.
5. Complete the Project Data Sheet with other information if applicable. The sheet has columns for an Identification number used by the submitter, a brief qualitative description of the sample, the mass of the specimen in grams, up to six separate hydration band readings, the mean hydration value, and comments about the specimen, thin section, or the thin section slide from the technician.
6. Cut the samples one at a time. Remove the thin section and mount it on the slide with the corresponding catalogue number. Note that the broken off margin of the thin section should face the slide label. Dry the specimen and immediately return it to its provenience bag. Repeat for each specimen in the collection.
7. Grind all the thin sections in the collection on the first side.
8. Reheat and invert the thin sections. Note that the broken off margin should still face the slide label.
9. Grind all the thin sections in the collection on the inverse side.
10. Dry the slides and glue the slide covers on the thin sections.

Reading the slides

With all the slides prepared, the technician can begin to make the hydration readings. This can be a time consuming process, so plenty of time should be reserved for this task. Too many people or noisy distractions in the lab can negatively affect results. In addition to the microscope, the Project Data Sheet for the working collection will be needed. The process of reading slides is summarized in the following steps:

1. Set up the microscope in a quiet area of the lab.
2. Retrieve the working collection of slides and arrange them in order.
3. Read each slide carefully
    a. Begin with the 10X objective to survey the perimeter of the thin section for readable locations. Use of the blue filter will assist in finding the hydration band.
    b. Change to the 40X objective and begin making readings six separate locations. Distribute the reading over the entire perimeter of the thin section.
    c. Record each value in the space provide on the Project Data Sheet.
    d. Calculate the mean value of the six readings for each slide and record it on the Project Data Sheet. There are four possible entries for the mean value field:
        i. A single mean hydration value of up to six separate readings in microns to one tenth of a micron (e.g. 4.1).

ii. A range of hydration values if the individual readings are more than 0.7 microns apart (e.g. 1.9 to 2.8).

iii. DH-Diffuse Hydration. The hydration front is so poorly defined no measurement is possible.

iv. NVB-No Visible Band. No hydration band can be identified.

4. Return the slides to the storage cabinet and put the microscope away.
5. File the Project Data Sheet with the other project documentation.

Reporting results

After collecting and recording the data, technicians must report findings to the submitting individual or agency in a professional manner. The hard copy of the Project Data Sheet will always remain with the collection in the lab. This provides a backup of the electronic database in the lab.

The first step of communication results is to transfer the information on the Project Data Sheet to an Excel spreadsheet in the electronic database called the Results Summary Table. This spreadsheet is a simplified version of the Lab Data Sheet that will be attached to the Results Letter that is given or mailed to the client. Currently, the letter is a Word 2007 document and a master is stored in the SJSUOL section of the Anthropology Laboratory computer. In addition to the salutations and the Results Summary Table, the letter has a brief methods section that describes how the lab obtained the reported results from the submitted collection.

Notwithstanding the above process, a separate procedure for verification of all formal results is required depending on the experience of the technician doing the hydration analysis. The necessity for data verification is associated with an understanding between the Anthropology Department and Tom Origer regarding the training of technicians and ongoing hydration work at the university. This agreement, forged at the time of Tom Origer agreed to train me in the hydration technique, expresses both parties desire to insure that only quality readings are entered into the archaeological record. As the responsible faculty member for the SJSUOL at the time of this writing, Dr. Marco Meniketti is the Department’s representative for this agreement and all decisions relating to the release of data from SJSUOL must be deferred to him.

Part II: Obsidian Trade at Sand Hill Bluff

Introduction

Establishing and refining regionally distinct cultural chronologies has been a long-term goal for many California archaeologists. Studying the distribution of exotic goods, especially obsidian, and radiocarbon dating have been important tools when working toward this goal. Archaeologists working along the North Central Coast (defined as extending from the Pajaro River north to the coastal terminus of the San Francisco peninsula) have developed tentative cultural chronologies and trade patterns. Unfortunately, these interpretations have been limited due to the small number of sourced obsidian artifacts, radiocarbon dates, and large-scale excavations. In this regard, further radiocarbon dating of material from appropriate contexts, obsidian sourcing, and hydration are needed to refine local chronologies and gain a better understanding of regional trade patterns in exotic material such as obsidian. This project will undertake the analysis of new material excavated from CA-SCR-7, a Middle Holocene site on the North Central Coast commonly known as Sand Hill Bluff. I use the new data to test tentative interpretations by Jones and Hildebrandt (1990) regarding obsidian use at the site over time and the relative strength of exchange networks.

In the summer of 2008, students from Cabrillo College, in conjunction with California State Parks, excavated portions of CA-SCR-7 during an archaeological field school. An obsidian sample (n=24) from three control units are the basis for testing the findings from the 1990 Jones and Hildebrandt project—the only other controlled excavation of the site. This paper presents new data from radiocarbon, obsidian sourcing, and hydration analysis relative to those previous findings. An additional comparative collection (n=20) of surface collected obsidian is also used in parts of the analysis.

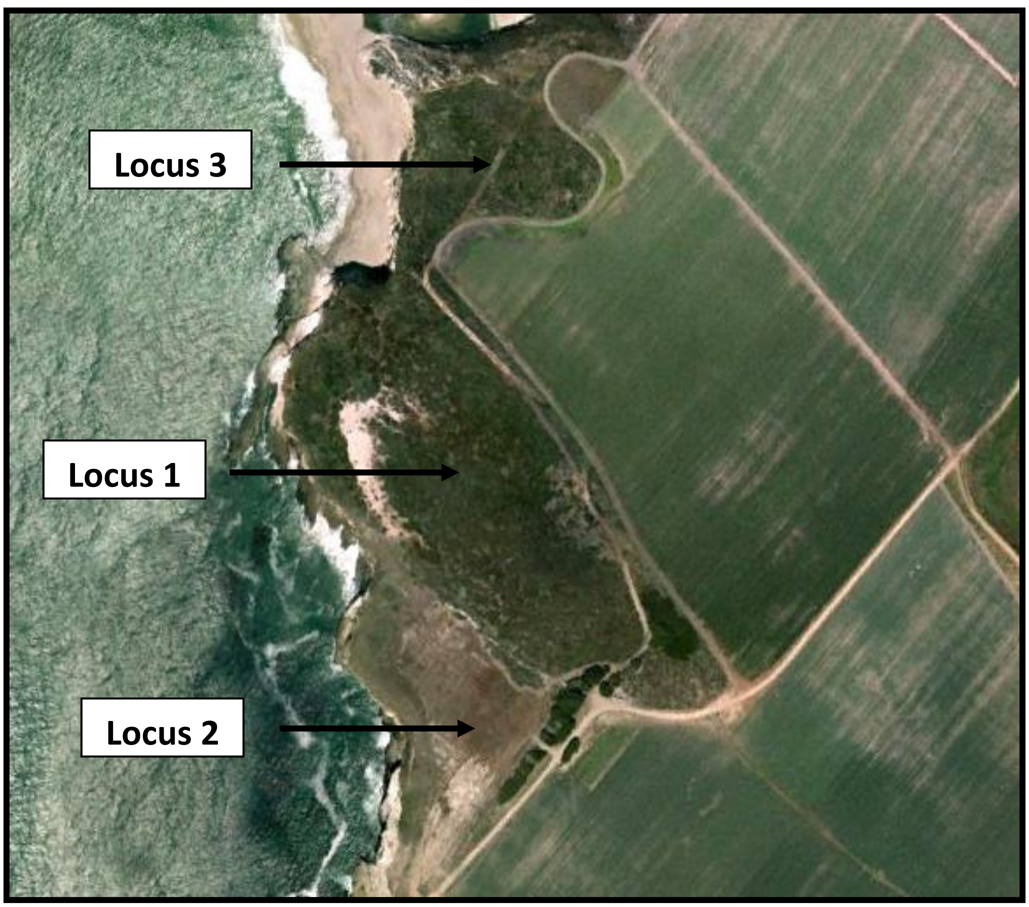
Background

CA-SCR-7 is an extensive prehistoric shell midden located on the coastal terrace eight km, or five miles, northwest of Santa Cruz, California (see Figure 3).

Source: County of Santa Cruz GIS

Figure 3: Sand Hill Bluff (CA-SCR-7) on the North Central Coast

At this location the coastal terrace is about 65 feet above mean sea level (AMSL). The archaeological geography of the site can be summarized as three elements: Locus 1 is the main portion of the site and consists of a large dune structure containing two distinct prehistoric cultural strata. The dune rises approximately 45 feet above the coastal terrace. Locus 2 is flat midden located to the south of Locus 1 in an area now under cultivation. Locus 3 is a smaller dune structure to the north of Locus 1 that rises about 20 feet from the top of the terrace. This part of the site has yet to be analyzed in any detail, but is thought to contain similar cultural deposits as found in Locus 1 (Hildebrandt, Jones and Hylkema 2006). With the entire site located very near the bluff face, the west facing portions of Locus 1 and 2 are exposed and impacted by erosion of the bluff into the Pacific Ocean (see Figure 4).



Source: County of Santa Cruz GIS

Figure 4: Sand Hill Bluff (CA-SCR-7) Site Geography

A modest series of radiocarbon dates suggest that Sand Hill Bluff was first occupied about 5500 years before present (YBP), at the transition between what has been called the Milling Stone Horizon (10000-5500 YBP) and the Early Period (5500-3000 YBP). The main period of occupation appears to be during the Early and Middle Periods (5500-1000 YBP) with some indications of a late occupation to about 700 YBP (Hildebrandt, Jones and Hylkema 2006). Figure 5 depicts a regional chronology for the Central Coast of California.

Cultural Period	Dates (YBP)
Late Period	1000-Contact
Middle Period	3000-1000
Early Period	5500-3000
Milling Stone Horizon	10000-5500
Paleo-Indian Period	Pre 10000

Adapted from Hildebrandt, Jones, and Hylkema 2006

Figure 5: General Cultural Chronology of the North Central Coast.

While older sites along the coast of California have been found that appear to significantly predate CA-SCR-7, most notably those in Southern California in and around the Channel Islands, the site continues to play an important role in regional chronologies as one of the oldest sites North Central Coast of California (Moratto 1984). Sand Hill Bluff was added to the National Register of Historic Places in 2006.

Previous Investigations

The first published reference to the Sand Hill Bluff site appeared in 1873 in meeting minutes of the California Academy of Sciences. Dr. A. W. Saxe reported finding a 12 to 15-foot thick midden containing projectile points and other flaked stone artifacts as well as a crescent shaped knife. The site was formally recorded by representatives of the University of California in 1950 (Hildebrandt, Jones and Hylkema 2006).

In 1973, paleobiologist G. Victor Morejohn of San Jose State University conducted a limited excavation of the site in search of faunal remains. His report included the discovery of Middle Holocene age remains of an extinct flightless duck (*Chendytes lawi*) and two radiocarbon dates from mollusk and barnacle shells. The shellfish from the upper component produced a measured age of 3780 +/- 95 years BP. The lower component produced a measured age of 5390 +/- 100 years BP, establishing the site as one of considerable antiquity (Morejohn 1976). These samples have been recalibrated by Gary Breschini using Calib 4.3; the intercept BP for these two samples are 3971 and 5940 respectively (Breschini 2010).

Hylkema (1991) analyzed 108 projectile points collected by local pothunters from the site's dunes and cultivated fields. While obsidian points represented a significant portion of the collection, none of the points were sourced or subjected to obsidian hydration testing. The study focused instead on the use of point typologies as temporal markers in testing the forager and collector adaptive modes proposed for the Monterey Bay area a decade earlier (Dietz and Jackson 1981) following Binford's (1980) description of the two settlement systems. Hylkema concluded that a generalized foraging strategy, thought to have been replaced by more elaborate collector strategies during the Middle Period in many locations, persisted at Sand Hill Bluff through the Middle Period to the Late Period (Hylkema 1991).

The first controlled excavation of the site occurred in 1988 as part of a California Environmental Quality Act (CEQA) project by Far Western Research Group, Inc. in response to a proposed abalone farm. Eventually, a survey, test excavation, and a data recovery-mitigation excavation program resulted in the analysis of over 20 cubic meters of material from Loci 1 and 2. The project resulted in far greater clarity with respect to the two temporal components of the site—a basal Early Period stratum marked by large amounts of shellfish debris dominated by mussel, an abundance of Monterey chert debitage, no obsidian debitage or tools; and a superimposed Middle Period stratum marked by significantly less shellfish debris, a similar abundance of Monterey chert, and a small amount of obsidian (Jones and Hildebrandt 1990). Both strata contained remains from a broad spectrum of both marine and terrestrial mammals consistent with the forager adaptive mode.

The study produced one radiocarbon date from a stellar sea lion (*Eumetopias jubata*) bone found at 80-90 cm in Loci 1. The sample returned a measured age of 5970 +/- 120 BP, the oldest basal date for SCR-7 yet recorded. This radiocarbon date has been recalibrated by Gary Breschini to 6308 (Breschini 2010).

A sample (n=14) of obsidian artifacts (12 pieces of debitage and 2 bifaces) were recovered and subjected to sourcing and hydration analysis. Results included that the obsidian had three points of origin—two from the North Coast Ranges (Napa [n=9] or 64 percent; Annadel [n=1] or 7 percent) and one from the Eastern Sierra Nevada (Casa Diablo [n=4] or 20 percent). Eleven specimens yielded hydration readings and three specimens of Napa obsidian were tightly clustered (3.3, 3.4, and 3.5), suggesting a Middle Period occupation based on a conversion factor that equates a Napa obsidian hydration range of 2.3-4.1 microns to 1000-2800 YBP (Jones and Hildebrandt 1990). Interpreting the data in regards to trade activities, Jones and Hildebrandt concluded that:

> "…obsidian use during the Middle Period was apparently confined to the casual importation of finished tools that were later retouched at the site. While Napa flakes dominate the assemblage, the sample size is too insignificant to confidently attribute this factor to strong exchange networks and affiliations with North Coast Range groups and/or resource procurement trips into these northern territories." [Jones and Hildebrandt 1990, 54]

Research Design and Theoretical Considerations

Research Design

This project addresses the question: *What was the nature of obsidian exchange at Sand Hill Bluff?* The study uses an approach that situates the obsidian recovered in 2008 from the untested southeast portion of the main dune structure (Loci 1) in a direct comparison with the smaller obsidian sample collected in 1990 by Jones and Hildebrandt. Radiocarbon dating is used to confirm the antiquity of the site in this location. Material patterning of source specific obsidian, under the temporal control provided by obsidian hydration measurements is used to analyze the obsidian as was the case for the smaller obsidian sample obtained in 1990 by Jones and Hildebrandt. Lithic technological analysis is also employed to characterize the obsidian assembles in detail. The comparison of the two samples will support corroboration, amplification, or redirection of the 1990 findings, which have been restated in the specific research questions below:

- Does the untested southeast portion of the main dune structure, Locus 1, at Sand Bill Bluff date to the Early Period as predicted by Jones and Hildebrandt's (1990) stratigraphic description?
- Was Napa obsidian (specifically) and North Coast Range obsidian (generally) dominant over other source locations at Sand Hill Bluff?
- Were finished tools or less formed tools imported and worked at the site?
- Does the temporal distribution of obsidian by source suggest larger patterns of exchange networks or trade affiliations over time at Sand Hill Bluff?

Theoretical Considerations

In the broadest sense, the purpose of archaeological investigations such as the present study is the advancement of knowledge about Native American peoples California at points in time during the 11000 to 15000 years humans have been in the region (Erlandson, et al. 2007). At the beginning of this time span we find consideration of the origins of human occupation in the Americas and how that development may have played out in California—an epic undertaken in the realm of grand theory at a global scale with but scant physical evidence (Meltzer 2009). At the other end of the spectrum are the fine-grained analyses that attempt focused explanations of particular material remains, often with the additional aid of ethnographic data. As the name implies, the Middle Holocene (5500-3000 YBP) can be seen as falling in between these extremes chronologically and theoretically.

Compared to the study of more recent cultural phenomenon, the temporal distance involved with the study of the Middle Holocene makes the use of any direct historical approach problematic. Confidence in analogies to living people and written records diminishes considerably with time, and 5500 or 3000 years is a long time in this context. However, dealing with this issue through a functionalist approach is reasonable. From mid-20th century writings on cultural development (White 1959; Steward 1955) we find persuasive argument that cultures are not comprised of independent or random traits, but rather traits that are integrated and dependent. Cultural traits influence each other and have a strong relationship to group adaptations to the environment. It follows that subsistence and settlement strategies can develop in fairly predictable and systemic ways within similar environments, and further, that the archeological record can be indicative of these past cultural systems (Binford 1980).

Relative to the study of the first Californians, the Middle Holocene's now static archaeological record is relatively abundant with physical evidence. Food processing implements, tools, projectile points, shell beads, and intact burials are found significant quantities. While the isolated hearth from 15000 years ago can speak volumes to the theorists with an otherwise blank slate, the obvious cultural complexity of the Middle Holocene begs for inferences and linkages between dynamic causes and their static remains.

As a means of mediating between the past and the present using the independent data presented in this study, it is helpful to consider the concept of middle-range theory. Given the setting and period of the present study it seems appropriate to use Binford's (1980) description of the dynamic patterns of foragers and collectors and how their material remains would be recognized as such in the archaeological record. This approach would also remain consistent with previous approaches to the study of subsistence strategies in the region of Sand Hill Bluff (Hylkema 1991)(Dietz and Jackson 1981) as well as the study of the site (Jones and Hildebrandt 1990).

According to Binford, foragers are highly mobile group of various sizes that "map on" to resource areas in a daily quest for food and where storage of food is limited to immediate needs. Foragers find food on an encounter basis during short procurement trips. Procurement trips radiate from "residential bases" that are used until the resources of a given area have been exhausted. Residential moves are frequent and likely to correspond to patches of abundant water and diverse resources. The availability of water or particularly desirable food supplies may "tether" forager groups to certain areas, contracting the overall area of seasonal rounds. Redundant use of residential bases is correlated with the accumulation of materials related to processing and maintenance activities that increase archaeological visibility, such as exotic trade items, hearth features, stone tools and debitage, and food processing tools and debris. By contrast, evidence of procurement trips would be limited due to the fact that functionally specific “locations,” such as kill sites, are occupied for very short periods and likely have little redundant use from year to year.

Collectors have an increased logistical approach to subsistence in the form of the storage of food for seasonal use and the deployment of “task groups”. Task groups are small parties of skilled people with specific resource collection goals that make it possible for the main social group to be located near productive areas while still exploiting other productive areas for specific materials. To do this, task groups detach from the main group for longer periods than forager procurement parties, setting up “field camps” to serve as temporary home basis during resource collecting activities. Task groups also use “stations” for logistical controls such as observing game or coordinating collecting activities and caches for storing large bulk resources for later use by the larger social group. Residential moves by collectors are less frequent owing to the use of task groups to increase resource exploitation in a single location, however, winter and summer accommodations still make sense given the annual cycles of major plant and animal communities and seasonal climate variation.

Forager and collector strategies are combined to varying degrees on a graded scale of characteristics from simple to complex. Collectors will be foragers and also organize logistical operations in increasingly complex adaptations. As logistical complexity increases, inter-site variability similarly increases (Binford 1980).

Geochemical Sourcing and Obsidian Hydration

The theoretical basis of geochemical methods used in the study of artifacts and exchange systems can be thought of as having two parts. The first part is not particularly complicated provided one can trust to the hard sciences certain details of the periodic table not typically found in the archaeologists' tool kit. Specifically, there must be a way to "read" the elemental signature of a particular material (Shackley 2005). Fortunately for archaeologists, the motivation for the development of such methods has existed in the field of geology for many years. These methods, based on the principles of physics, chemistry, and earth science, have steadily increased in number and accuracy since the first identification of archaeological materials by petrographic analysis in 1948, and their increasing usefulness is strongly associated with a dramatic increase in the study of prehistoric exchange and trade in the past 25 years. Today the list of techniques is impressive: neutron activation (INNA), x-ray fluorescence (XRF), proton-induced x-ray emission (PIXE), thermal ionization mass spectrometry (TIMS), among others (Glascock 2002).

The other part of geochemical characterization theory, the Provenance Postulate, is far more intuitive than subatomic particles, and just as important. Proposed by Weigand et al. in 1977 and restated in 2001 by Neff, the concept is a requirement for successful sourcing by chemical differences (Glascock 2002). The Provenance Postulate states: "Sourcing is possible as long as there exists some qualitative or quantitative chemical or mineralogical difference between natural sources that exceeds the qualitative or quantitative variation within each source" (Neff 2001, 107). Provided the postulate is true for a particular set of sources, reading the "fingerprint" of obsidian artifacts by the methods listed above yields a tangible connection between source and site that is invaluable to the study of exchange.

If the Provenance Postulate is a minimum requirement for a material to be reliably sourced, then obsidian gets a high grade. As Michael Glascock wrote in the introduction to his edited book *Geochemical Evidence for Long-Distance Exchange* (2002), among materials typically characterized in provenance studies "…obsidian represents the ideal archaeological material useful for sourcing. Individual obsidian sources are highly homogeneous, but the differences between sources are so significant that they can be easily observed by any of the several analytical methods…" (Glascock 2002, 2).

Accounting for this fortunate fact is the comparatively simple and abrupt genesis of obsidian as an igneous rock. Obsidian forms when high silica magma is extruded during periods of volcanic activity. The magma finds paths to the surface through existing rock that impart particular trace elements and minerals that later serve to identify the obsidian. That most extrusive events are short in duration is critical to increasing the homogeneity of the extrusion, since the chemical composition of both the magma and the matrix through which it passes can remain essentially constant throughout the event. Rapid cooling at the surface also contributes to the lack of intra source variation, as there is little time for newly extruded material to mix with other material at the surface (Monroe and Wicander 2001).

While it is possible to source other lithic material found in archaeological sites such as chert, steatite, and basalt, the more complex geologic history of these materials makes sourcing more complicated and far less reliable. Similarly, material that has been physically and chemically altered during human modification, such as fired clay or smelted metal, proves difficult to source to its original location (Glascock 2002).

Obsidian has another unique property that affords great opportunity for researchers. Over time, obsidian absorbs water molecules from the atmosphere that can be viewed and measured in cross section with high magnification. In 1960, geologists Friedman and Smith discovered “hydration” as they studied the various properties of volcanic glass from around the world. During this work they noted the correlation between age and the growth of “hydration bands” that are measureable intrusive layers of water molecules on the exterior margins of obsidian specimens. They combined this information with their further recognition of the association between obsidian and perlite, the amorphous volcanic glass with high water content (3.5 percent) that forms naturally through the hydration of obsidian. Perlite eventually spalls from the non-hydrated obsidian core (0.1 to 3.3 percent water) when the hydration band approaches 40-60 microns. Taken together this information suggested that the hydration of obsidian was continuous and therefore predictable. Friedman and Smith published the article *A New Dating Method Using Obsidian: Part I, The development of the Method* (1960), wherein they presented their discovery.

Freidman and Smith proposed a mathematical model of the hydration rate that could be used to derive estimated dates the date when new margins on obsidian specimens had been first exposed to the atmosphere. Where obsidian is found in association with archaeological sites this has come to mean when obsidian has been most recently modified by humans. This model ($T=kx^2$), where T is years before present, k is a constant, and x is the hydration band thickness in microns, is described as a diffusion reaction (Friedman and Smith 1960).

Prehistoric Exchange

As noted above, the proliferation of exchange studies is related to the development of reliable high resolution geochemical sourcing and new dating methods (Shackley 2005). The increase is also associated with the recognition by archaeologists at about the same time that exchange in prehistory is “central to maintenance and change in cultural systems” (Earle and Ericson 1977, 3). This view of material exchange as integral to cultural studies reflects a functionalist perspective frequently focused on economic rather than social implications (Jackson 1986). Mathematical modeling has also been an area of concentration, forwarded by such researchers as Renfrew.

Ericson (1977) developed the notion that a group’s local environment, and specifically what it does and does not offer in the form of needed supplies, is one of the principle drivers in the development of exchange systems. For example, Ericson analyzed ten obsidian sources in California and eastern Nevada and the obsidian specimens recovered for 52 sites of similar antiquity throughout the same area. The resulting synagraphic contour map showed clearly the obsidian exchange systems functioning at the time. He then superimposed the location of three variables: prehistoric trails, the geography of alternative lithic material sources (Franciscan chert, Monterey chert, and the Sierra Nevada granite and non-granitic formations) and the ethnolinguistic groups as formulated by Kroeber in 1925. By far the closest correlation explaining the shape and intensity of the exchange systems was the presents of locally available alternative lithic material. That is, the exchange systems attenuated were local material was abundant and proliferated where it was not (Ericson 1977).

This theoretical thread is particularly germane to the present study as Sand Hill Bluff is situated atop a significant deposit of Monterey chert. Abundant quantities of Monterey chert at Ano Nuevo just 6 miles north of the site were managed by local people and likely added to the regions independence from groups with access to other lithic materials such as obsidian and Franciscan chert (Hylkema 1991). The minute quantity of obsidian at Sand Hill Bluff therefore has a functional explanation and may help characterize the nature of obsidian trade as it developed over time.

As another result of better geochemical characterization methods, Renfrew began highlighting regularities involving classes of artifacts, including pottery and chipped stone, and the procurement of the associated raw material from a distance. The most rudimentary regularity is where raw material is highly localized and the abundance of the material in archaeological contexts decreased with distance—what Renfrew generalized as his *Law of Monotonic Decrement* (Renfrew 1984, 136). Renfrew saw in this fairly obvious generality the ability to model the "fall-off" curve mathematically in much the same way geographers describe distance decay effects, thereby making interesting variations of the phenomenon detectable, and further, perhaps then being able to associate variations with economic and social processes. Essentially, the math is an algebraic description of the curve created when the measure of commodity abundance is plotted against the distance between sites and a particular source. To the extent that predictive models from different times and places share similarities and differences, much might be said regarding the similarities and differences of the generative economic and social forces associated with them (Renfrew 1984).

To the degree that ancient geologic deposits and fall-off models might still leave many uncorroborated details about trade networks, Jackson (1986) attempted a rigorous combination of geochemical methods and spatial analysis of obsidian artifacts to complement the ethnographic record in late period north central California. This was a major departure from the previous generation of California exchange studies such as Davis (1974) where the goal was simply to catalog which groups traded with each other and what materials and products were traded. Jackson's goal was to explore economic organization, cultural complexity, and commodity exchange across territorial boundaries through geochemical and physical analysis of obsidian. The data were combined with ethnographic data generally lacking in detailed descriptions of exchange, but relatively informative regarding ethnic boundaries that might explain geographic patterns of archaeologically recovered obsidian.

The study, performed at a much smaller scale than Ericson's California and Nevada study and within one node of obsidian source abundance (North Coast Ranges), noted that obsidian was imported despite available local materials, traded in a variety of forms (finished tools, partial artifacts, raw material) across some boundaries and not others, and exchanged largely in coincidence with marriage between tribal elite. Exchange was centered on the elite in "primary groups" that controlled principle obsidian sources, and that produced obsidian in quantities well in excess of their own needs. Social relations extended from elites through marriage and were a major determinant of direct trade with other groups to a radius of approximately 40 km. This supported the that native societies in the region of the North Coast Ranges were non-egalitarian and that obsidian production and trade were effected more by social factors than utilitarian considerations (Jackson 1986).

Focusing on the antiquity of trade, (Fitzgerald, Jones and Schroth 2005) reported *Olivella biplicata* shell beads 365 km from the coast as that suggest ancient trade between the southwestern Great Basin and the central coast of California dating to between 10300-10000 CAL YBP. Early coastal people had apparently established trade in *Olivella biplicata* shell beads with interior groups within only a few millennia of the earliest evidence of coastal peoples on the central California coast (13000-12000 CAL YBP) (Erlandson 1994). While the authors acknowledge the possibility that the deposition of the shell beads in the interior were the result of wide-ranging terminal Pleistocene groups that included the coast in their travels, they attribute the find to at least one incidence of exchange between independent groups—the earliest evidence for such exchange.

Native American Populations at Sand Hill Bluff

The first people in California were likely of Asian descent and arrived in California from the north about 15000 to 11000 years ago (Erlandson et al. 2007). Whether they got to the region by land or sea route or a combination of both is less well established (Meltzer 2009). While evidence in favor of a sea route as the first mode of entry is modest, certain arguments regarding the potential benefits of the ecological continuity provided by the “kelp highway” of the northern Pacific Rim are compelling (Breschini and Haversat 2008), land migration via the “ice free corridor” still has many proponents (Meltzer 2009).

Despite many theories of what might have transpired between the one or several migrations to California by various groups, it is general established that the present day Native Americans descend from the earliest people. Following initial colonization populations grew and differentiated along various cultural paths, leading to a diverse mosaic of native culture and language, particularly in California (Meltzer 2009). Regarding the populations in the area of Sand Hill Bluff and the greater San Francisco Bay area, later movements of these groups in the western part of North American may have create one or more population replacement scenarios among groups independent groups (Breschini and Haversat 2002).

Specifically, ethnographic, linguistic, and archaeological evidence suggests that the Ohlone (also known as Coastanoan in earlier literature), are part of the Utian language family groups that also includes the Bay Miwok and Coast Miwok. Certain models have suggested that the Ohlone migrated to the Bay Area about 2000-4000 YBP from the northwest (Breschini and Haversat 2002). Geographically associated linguistic subgroups of the Ohlone included Ramaytush of the San Francisco peninsula, Tamyen in the Santa Clara Valley, Chochenyo in and around the East Bay, and Karkin around the Carquinez Strait. Considerable blending of these closely related dialects can be attributed to severe post-contact cultural disintegration, especially during and after the Mission Period (Milliken 1995). Many descendents from the mission system in San Mateo, Santa Cruz, and Monterey Counties are represented today by the Muwekma Ohlone Tribe of the San Francisco Bay Area. While the last native speaker of one local post-mission dialect, Jose Guzman, died in 1934, the Muwekma Ohlone Language Committee initiated an effort to revitalize the language beginning in 2003 (Peralto 2008). What is known of the descended languages are preserved in a dictionary based on the notes of J. P. Harrington in the early 20th century and compiled by Professor Catherine Callaghan. The Tribe's Language Committee reprinted the dictionary in 2005 as a reference for modern people and as a tangible base of knowledge for future language revitalization efforts.

In addition to their interest in language preservation, the Muwekma Ohlone Tribe has had to address impacts Bay Area prehistoric and historic sites. As a documented Native American group in the area, the Tribe has been affected by disturbances to prehistoric and historic archaeological sites which are of cultural significance to their community under the California Environmental Quality Act (CEQA). As such, the Tribe views destruction of sites as impacting their traditional lands, culture, and heritage values, particularly where village and cemetery sites are involved (Leventhal et al 2011; Field 2008).

The Muwekma Ohlone Tribe also has great interest in new archaeological findings about their past. The Tribe has operationalized its interest through research collaborations with students and professionals from many institutions of higher learning including SJSU as well as through its own CRM firm, Ohlone Families Consulting Services.

The involvement of Native Americans as stakeholders supports a multivocality that is usually associated with the post-processual critique of processual archaeology (Balter 2006). This critique insists that multivocality be taken seriously and recognizes that the singular voice of the archeologist as the all knowing voice of the past is counter to the notion that the past was similarly multivocal. The opinions of individuals and communities with an interest in past civilizations needed to be included in the interpretive process (Hodder 1986). The present study seeks to be sensitive to the post-processual critique not only through familiarization with the historical trajectory and complexity of Muwekma Ohlone culture, but also through engagement with the contemporary Tribal community in the context of the San Jose State University Obsidian Laboratory (SJSUOL), an organization designed for an open dialogue between the native community and SJSU student researchers.

Methods and Materials

Fieldwork

The Cabrillo College field school excavations at CA-SCR-7 began on July 5, 2008. Students excavated four 1X2 meter units and one column sample per unit. Units 1-3 were located in the southeast portion of the site on the margin of Locus 1 as it transitions into the level marine terrace. The fourth excavation unit from 2008, located at Locus 3 in the north portion of the site. All units were hand excavated in arbitrary 10-centimeter levels measured from a unit datum. Excavated soils were screened in nested 1/4, 1/8, and 1/16 inch mesh screens on site.

Laboratory Methods

Sorting

Students sorted the bulk 1/4 inch material from Units 1-3 into the following categories: bone, shellfish, chert flakes, obsidian flakes, flake tool, biface, projectile point, shell beads, and fire-affected rock. Flaked stone debitage, bone and formal artifacts were weighed and counted. The 1/4 and 1/8 inch column samples for these three units have also been sorted into the same categories. In addition, the shellfish and the bone from the column samples have been speciated into eight and three subcategories respectively. The material recovered from Unit 4 remains unsorted.

Lithic Analysis

Laboratory efforts produced an obsidian sample of 24 flakes of debitage. Students weighed the specimens and attempted a basic technological evaluation. At this point, the assignment of lithic flakes into nominal categories of the lithic reduction process is quite standardized. The decision to assign a specific flake to a certain category was based on typological discussions with Dustin McKenzie, Archaeology Instructor, Cabrillo College, as the flakes were recovered during the sorting operation.

Within a SPSS (version 17.0) statistical software database for the obsidian specimens, two variables were defined to describe the 24 flake specimens. The first variable is a common technological segregation of three categories based on the observed cortex on each flake. Student technicians examined each flake carefully using 3X and 5X magnification for the presents of cortex, recording a category for each flake. The flakes were listed as primary (nearly 100 percent cortex on the dorsal aspect); secondary (some cortex on the dorsal aspect); or tertiary (no cortex) (McKenzie 2010).

A finer breakdown of the sample is noted in a second diagnostic variable based on the morphology of the specimens. This variable has five nominal categories representing different technological attributes that are understood to be somewhat subjective: percussion flake, early biface thinning flake, late biface thinning flake, pressure flake and shatter. A percussion flake as defined here has a broad bulb of force and is thick from the dorsal to the ventral aspects relative to its longitudinal length. An early biface thinning flake has a single-facet platform and a simple dorsal topography, while a late biface thinning flake has a multifaceted platform and a more complex dorsal topography. Pressure flakes are quite small and have a simple dorsal topography with a single-facet platform. Shatter is used to describe obsidian fragments that lack the above diagnostic attributes of flakes, and are the random waste products of the reduction process.

Obsidian Sourcing

The obsidian specimens from the 2008 Cabrillo excavation were sourced using energy dispersive x-ray fluorescence analysis performed by Richard Hughes at the Geochemical Research Laboratory in Portola Valley, CA. While obsidian tools are typically large enough to permit artifact-to-source attributions on the basis of correspondence in diagnostic trace element concentration values, Dr. Hughes concluded that all of the obsidian specimens from SCR-7 "were too small and thin to generate x-ray counting statistics adequate for proper conversion from background-correcting intensities to quantitative concentration estimates." Instead, sourcing was based on "integrated net count intensity data for the elements Rb, Sr, Y, Zr, Nb, Mn, and Fe" (Hughes 2010, 1).

A supplementary collection of surface collected specimens was lent to the project by Gary Breschini, Archaeological Consulting, and Mark Hylkema at California State Parks. The collection is hereinafter referred to as "Surface" collection. This data set consists of four small flakes collected along with shell samples for radio carbon dating in the 1980s, and 16 point fragments recently acquired by State Parks from pothunters that have collected artifacts at Sand Hill Bluff in the past. These specimens were visually sourced by Tom Origer at OOL. Given the non-random nature by which the point fragments were recovered, only limited use is made of this collection in this study.

Obsidian Hydration

Tom Origer performed hydration testing on the 2008 Cabrillo obsidian samples at the OOL. The author performed hydration testing on the supplementary sample at the SJSUOL, however, all results were verified by Tom Origer at OOL. Only 16 of the 20 specimens in the Surface collection yielded hydration readings. In both cases laboratory procedures used to cut and mount the obsidian thin sections on slides conform generally to the method suggested by Friedman and Smith (1960). Hydration measurements for each specimen are an average of six readings from each thin section margin using a 40X objective and a 12.5X eyepiece mounted on a polarizing microscope.

The conversion of mean micron values into YBP is based on the diffusion rate equation ($T=kx^2$) (Friedman and Smith 1960), where T is YBP, k is a constant defined for the Napa source as 153.4 (Origer 1987), and x is the hydration band thickness in microns. The data were controlled for source using conversion constants between sources (Tremaine 1989) and controlled for Effective Hydration Temperature (EHT) (Basgall 1990) with information from the Western Regional Climate Center.

Radiocarbon Dating

Chronometric dating services from the Center for Accelerator Mass Spectrometry at the Lawrence Livermore National Laboratory (LLNL) provided a suite of four AMS radiocarbon dates for radiometric temporal control. LLNL processed four single shell samples of mussel shell (*Mytilus californianus*) from Unit 2. One sample each came from depths of 90-100, 110-120, 120-130, and 150-160 cm. Calibrated dates were derived by Gary Breschini using Calib 4.3 software for the Intercept BP Delta R 225.

Data

Radiocarbon Dating

As reflected in the first research question, the accurate dating of the archaeological context excavated by Cabrillo College Field School in 2008 is a high priority of this study. The method of obtaining chronological data from this context was AMS radiocarbon dating. Despite the obvious disturbance to portions of the site by the agricultural land uses, it appears features and undisturbed contexts are present in least a portion of the excavated areas in the southeast portion of Locus 1.

Specifically, within Unit 2 excavators found an abundance of fire affected rock (FAR) and charcoal that likely indicated the presence of a hearth feature (Feature 1) between 90 cm and 150 cm. The main constituent of the FAR was fourteen rocks of very similar size and shape in a consolidated mass between 110 cm and 120 cm. The mass of rock occupies a space of approximately 0.06 cubic meters. Anthropogenic soil and dense shell deposit indicative of shell midden completely surrounded Feature 1 and strongly suggest human activity in antiquity. Figure 6 shows the mass of FAR and charcoal by level. The quantitative measure of charcoal has been amplified by a factor of 100 in order to show the elevated levels of this material in the same graphic as the much heavier FAR. By comparison, the profile of charcoal by mass in Units 1 and 3 is imperceptible even when similarly amplified, underscoring the anomalous nature of this spike in charcoal within all the excavated material and its non-random co-occurrence with the FAR in Unit 2.

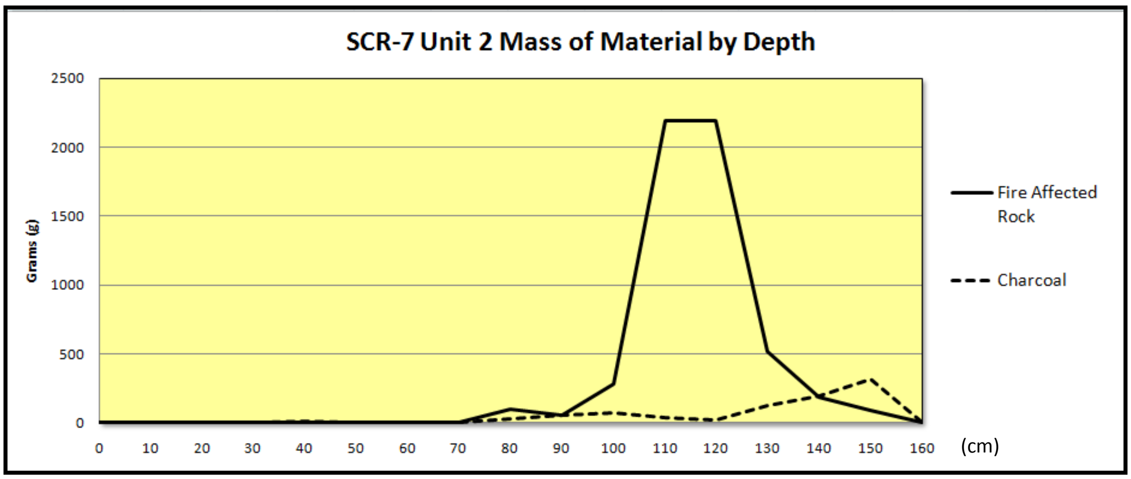


Figure 6: Unit 2 FAR and charcoal by mass. Charcoal mass amplified 100X.

Four AMS radiocarbon dates were generated from four single-shell samples of mussel shell (*Mytilus californianus*) at Lawrence Livermore National Laboratory (LLNL) in Livermore, CA. In order to maximize the association with Feature 1, samples were taken from Levels 90-100 cm, 100-110 cm, 110-120 cm, and 150-160, thus bracketing Feature

1 while also sampling the base level of the control unit. The results of the AMS dating are presented in Figure 7.

Level (cm)	Lab No.[1]	Conv. Age	Cal 2 sigma AD/BC	Intercept BP [2]
90-100	CAMS-146093	5390 ± 35	BC 3659-3491	5559
110-120	CAMS-146094	5605 ± 40	BC 3935-3663	5732
120-130	CAMS-146095	5605 ± 40	BC 3931-3675	5732
150-160	CAMS-146096	5670 ± 35	BC 3966-3751	5850

Figure 7: Unit 2 AMS dates associated with Feature 1. All single piece samples (*Mytilus californianus*). (1) Lawrence Livermore National Laboratories. (2) Calibrated using (Calib 4.3) Delta R 225 (Breschini 2011).

Obsidian Studies-Sourcing and Hydration

The small size of the flakes necessitated sourcing by integrated net count data for the elements Rb, Sr, Y, Zr, Nb, Mn and Fe by Richard Hughes, Ph. D., RPA at the Geochemical Research Laboratory for 22 of 24 specimens in the 2008 collection. Two additional flakes were visually sourced by Tom Origer at OLL. Results show 15 specimen (62.5 percent) from Napa Obsidian, four (16.7 percent) from the Casa Diablo area, three from Annadel (12.5 percent), and two (8.3 percent) from the Mt. Hicks source.

All 24 flakes were submitted to OLL for hydration analysis. One specimen did not have a readable hydration band due to diffuse hydration. The 15 Napa readings have a mean value of 2.9 microns (SD=0.795), which approximates to 1290 YBP. The very small sample of obsidian from other sources lessens the usefulness of their mean values.

As suggested by the standard deviation (0.797) for the Napa sample, the hydration readings show a widely dispersed pattern from a minimum reading of 1.4 microns to 4.5 microns, which equates to a calendrical date range of 345 to 3389 YBP. There is a concentration of hydration readings around the date of 1000 YBP, with the largest spike at approximately 1200 YBP, which corresponds closely to the mean value for the entire sample. Two discontinuities in the Napa hydration readings are associated broadly with 1500 YBP and 3150 YBP, as no readings correspond to within approximately 150 years older or younger than these dates.

The two samples from the Annadel source, the other North Coast Range, post date the peak in Napa values with dates of 443 and 811 YBP. Similarly, Casa Diablo obsidian (n=4) shows youthful hydration readings with a concentration of three readings between 742 and 959 YBP. The most recent reading (1.3 microns), corresponding to a date of 221 YBP, is also attributable to the Casa Diablo source. Mt. Hicks obsidian (n=2) has band readings (3.2 and 3.5 microns) which convert to dates 1118 and 1474 YBP, and are thus somewhat coincidental with the peak in Napa hydration values.

Lithic Characteristics

The obsidian assemblage for the Cabrillo 2008 excavations came from excavation Units 1, 2 and 3 located in the southeast portion of the main dune structure, or Locus 1. This new assemblage (n=24) consists exclusively of small debitage, ranging in size from less than 0.01 g to 0.29 g with a average weight of 0.045 g (SD=0.06). Only one (4.2 percent), the largest specimen (0.29 g), appears to have been removed with percussive force and has therefore been classified as a percussion flake according to definitions given in the methods section above. When this specimen is removed from the calculated mean, the remaining specimens are very similar by weight (mean=0.034, SD=0.03) and morphology. All of these small specimens are either late stage thinning flakes (62.5 percent) or pressure flakes (33.3 percent) as defined above. All specimens, including the one percussion flake are interior, or tertiary, flakes with no cortex remaining from the original volcanic deposition of the obsidian.

The surface collection appears to contain several point fragments that have been significantly retouched. During the visual sourcing of the collection, Tom Origer noted two specimens in particular that seem to have been reworked to from broken points to perforators, with wide bases and thickly reduced ends. Such reworking is common practice at sites with long terms of occupation and may help explain the very small size of the flakes in the Cabrillo 2008 collection (Origer 2010).

Discussion

With the data described above, we can now address the research question stated above: *Does the untested southeast portion of the main dune structure, Locus 1, at Sand Hill Bluff date to the Early Period as predicted by Jones and Hildebrandt's (1990) stratigraphic interpretation?* Regarding the antiquity of the southeast portion of the main dune structure that is Locus 1, the suite of AMS radiocarbon dates presented here (5559, 5732, 5732, 5940 cal YBP) may be the most compelling evidence yet in support of previously forwarded suggestions (Jones and Hildebrandt 1990; Hylkema 1991; Hildebrandt, Jones and Hylkema 2006) that undisturbed deposits exists within the main dune structure. The strong association of the new data with Feature 1 and the tight grouping of dates in superposition seem to confirm these claims emphatically. At the very least, the antiquity of the previously untested southeast portion of Locus 1 appears equivalent with the area excavated by Jones and Hildebrandt in 1990, recalibrated to 6308 cal YBP (Breschini 2010). Taken together, this is considerable support for human presence at Sand Hill Bluff prior to the Early Period, herein defined as 5500 to 3000, and further, that regular use of the site may in fact have been *well established* by that time.

The second research question can also be addressed. *Was Napa obsidian (specifically) and North Coast Range obsidian (generally) dominant over other source locations at Sand Hill Bluff?* While the small sample size of the 1990 collection was reason for caution, direct comparison of that sample with the more robust obsidian collection from 2008 suggests that the modest accurately predicted the percent of Napa source obsidian specifically and North Coast Range obsidian generally at the site. The comparison is shown in Figure 8 below. When aggregated, the obsidian permits less tentative statements about regional exchange networks and trade affiliations.

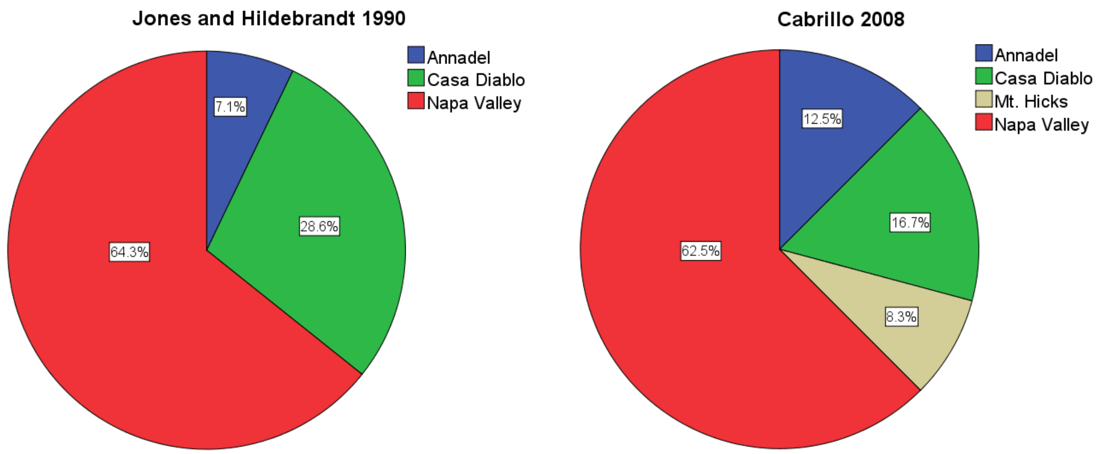


Figure 8: Obsidian source comparison. Jones and Hildebrandt 1990 (n=14), Cabrillo 2008 (n=24).

Specifically, 62.5 percent (n=15) of the 2008 Cabrillo assemblage (n=24) is attributed to the Napa source. A very similar percentage of the 1990 collection (64.3 percent) comes from the Napa source. When combined with specimens from Annadel, the only other North Coast Range source in both collections (Cabrillo [n=3], Jones and Hildebrandt [n=1]) the percentages are 71.4 percent and 75.0 percent respectively. All other obsidian in both cases can be attributed to Eastern Sierra sources (Casa Diablo and Mt. Hicks). These results are also consistent with Hylkema's regional study that included obsidian (n=137) from eight coastal sites (not including CA-SCR-7) from Santa Cruz and San Mateo Counties. He found 76 percent of the specimens were from North Coast Range sites, with Napa representing 63.5 percent of the total sample (Hylkema 1991). Thus, it appears that the small sample size analyzed by Jones and Hildebrandt did not impede the interpretation regarding where the obsidian in use at the site originated. It may well be that relatively strong trade networks or affiliations did exist between groups in the North Coast Range region and groups with a seasonal presence at Sand Hill Bluff.

Testing the third research question involves a more qualitative method of analysis. *Were finished tools or less formed tools the principal obsidian import at Sand Hill Bluff?* Complications exist with a direct comparison of the Cabrillo 2008 and Jones and Hildebrandt 1990 collections with respect to lithic analysis. The lack of specific information regarding the obsidian analyzed by Jones and Hildebrandt in 1990 permits only a partial comparison. In 1990, the specimens were only classified as “debitage” (n=12) and “biface” (n=2). Of the 12 debitage specimens, only ten are listed in the index catalogue with their weight. Only one of these has a mass greater than 0.1 g (0.6), with the remaining nine weights recorded as 0.1 g. It may be that this was intended to be <0.1 g, with smaller measurements rounded up to 0.1 grams. Despite this ambiguity regarding the mass of two specimens and the lack of qualitative descriptions of individual flakes, the very small size of the majority of the sample is certainly enough to appreciate the general conclusion drawn from the material in 1990. That is, that only late stage reduction in the form of finishing and retouching tools was the extent of lithic reduction on obsidian at the site.

As noted above, two variables were used to describe the obsidian flakes from 2008. Regarding the presence of cortex on the flakes, all 24 specimens lacked any cortex from the original geologic context, that is, they are all interior flakes. The technological classification of the flakes shows that all but one of the flakes are either late stage biface thinning flakes or pressure flakes, with one flake indicative of percussive reduction. The data by flake type are summarized in Figure 9 below:

Flake Type	Frequency	Percent	Cumulative
Late biface thinning	15	62.5	62.5
Pressure	8	33.3	95.8
Percussion	1	4.2	100
Total	**24**	**100**	

Figure 9: Cabrillo 2008 obsidian by flake type. Frequency and percent

While direct comparison between the two collections at the level of detail presented for the 2008 collection is not possible, the new flake collection does support a similar conclusion that only late stage tools were being finished and retouched at the site. There is no evidence that less formed tools were being imported and worked at the site.

Obsidian hydration as chronological control is required to address the final research question: *Does the temporal range of obsidian use by source suggest larger patterns of exchange networks or trade affiliations over time at Sand Hill Bluff?* In support of this question, the analysis is augmented by the “Surface” collection (n=16) described above. For the Cabrillo 2008 and Jones and Hildebrandt 1990 collections, the sample size for the hydration data is smaller, (n=23) and (n=11) respectively, owning to several instances where the hydration bands on particular specimens were too diffuse or weathered to provide useful measurements. The one specimen omitted from the

Cabrillo collection was from the Annadel source, and the three specimens from the Jones and Hildebrandt collection were from Annadel (1) and Casa Diablo (2).

The three collections are shown together in Figure 10 graphed over time (hydration date estimations) and segregated by source. Several patterns emerge that add to our understanding of the nature of obsidian exchange at the site. The first pattern that becomes apparent is that both the Cabrillo 2008 and Surface collections show obsidian use at the site much later than the 1990 sample. In fact, the majority of the 2008 Cabrillo sample, 18 of 23 specimens have hydration readings that convert to dates after 1500 YBP, with a mean value of 925 YBP. So, where the 1990 sample led to an interpretation focused on obsidian exchange during the Middle Period, the new data suggests that the most intense period of use may have been closer to the Middle/Late Period transition around 1000 YBP. This may be significant in that it coincides with other cultural changes suggested by Hylkema (1991, 2002) as taking place at the time. These changes are most notably the transition of coastal groups from a forager adaptive mode that was largely independent from the southern San Francisco Bay area populations to a collector adaptive mode more similar to the south Bay Area both socially and economically.

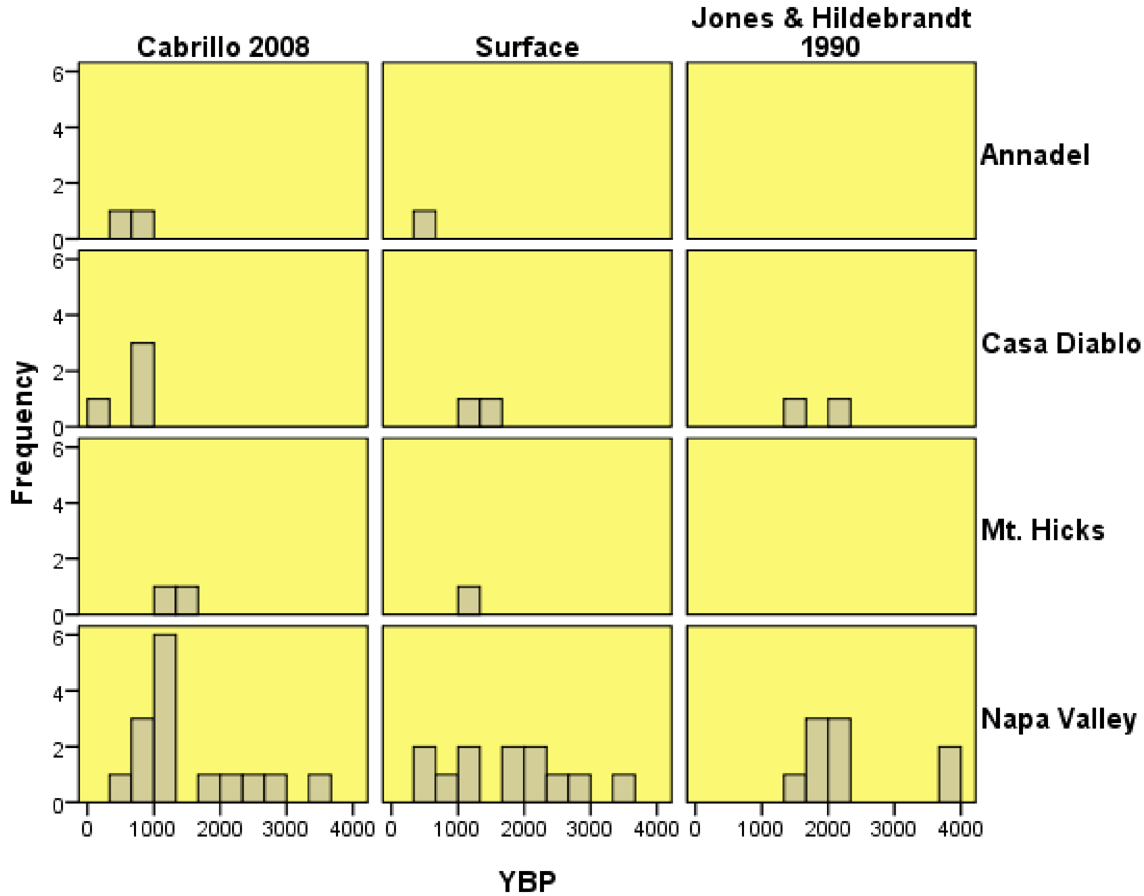


Figure 10: Comparison of the three study samples by source and hydration date equivalent. Cabrillo 2008 (n=23); Surface (n=16); Jones and Hildebrandt (n=11).

Perhaps related to the increase of obsidian in the later period is the increase in the number of sources detected in the new samples. All three new sources (Mt. Hicks, Casa Diablo, and Annadel), beyond the increase in Napa obsidian, seem to either emerge or re-merge, at a point around 1000 YBP. As noted above, two Annadel and two Casa Diablo specimens are not included in the hydration data set because they did not yield useful hydration readings. Since all the omitted samples are from these late emerging sources (Annadel and Casa Diablo) the strength of the apparent pattern may be taken as potentially weaker or stronger depending on when these specimens were produced.

This same pattern, however, can be found just over the Santa Cruz Mountains to the east at CA-SCL-65 in Saratoga, where a collection (n=56) of hydration readings by source indicates a similarly late (circa 1000 YBP) concentration of Annadel obsidian (n=4, 7 percent) where no earlier material from that source is reported (Fitzgerald 1993). The coincidence of this pattern may suggest whatever changes took place in the exchange networks affecting Sand Hill Bluff and other coastal sites were related to changes taking place in the Santa Clara Valley at the transition between the Middle and Late Periods. These changes are noted by Hylkema (2002) as a “florescence” of the southern bay area Ohlone groups that included increased interrelation of group economies, increased social hierarchy, refinement of wealth and status, and perhaps most important, increased demand for coastal specific material to display wealth and status such as *Haliotis* for Banjo pendants and *Olivella* shell currency . A line of exchange from the coast through the Santa Clara Valley near CA-SCL-65 would explain the coincidental appearance of Annadel obsidian at Sand Hill Bluff and Saratoga. This seems even more likely given that increased interrelations of groups economies in the southern San Francisco Bay resulted in increase economic range for the region (Hylkema 2002) and would have perhaps begun to overlap the southern extent of the Annadel distribution pattern to the north while at the same time increase connections with the burgeoning demand for Haliotis in the Central Valley (Hylkema 2002). The increased range may have increased the flow of coastal trade goods east and the flow of North Coast Range obsidian south then west to the coast.

Certainly the above pattern seems more plausible than direct trade from the coastal area of Sand Hill Bluff and the North Coast Range “Primary groups” described by Jackson (1986). These groups traded largely within a 40 km radius that coincided with the extent of marriage exchanges between elites, and the distance from Sand Hill Bluff to the North Coast Ranges (approximately 200 km) far exceeds this perimeter.

Before this Late Period peak in the present data, the flow of Napa obsidian appears somewhat stable and largely uninterrupted, suggesting long-term reoccurring contact between groups with a seasonal presence at Sand Hill Bluff and those with access to a regular supply of obsidian from the Napa source beginning about 4000 YBP. As noted above, this was likely not accomplished through direct trade, but rather through secondary and perhaps several secondary connections. Further, it appears that the relative dominance of Napa obsidian was similarly continuous until the aforementioned Late Period increase of obsidian from other sources.

Thus, it does appear that the small sample size from 1990 did somewhat obscure the both the breadth of obsidian use at Sand Hill Bluff as well the later diversification of obsidian by source that is shown in both of the two larger samples. As a consequence, the Jones and Hildebrandt sample was understandably focused on Middle Period exchange and did note the change indicated by the increase in obsidian from different sources in the later period of obsidian use.

Conclusion

It has been the goal of this project to be able to more confidently forward statements that describe the nature of obsidian trade at Sand Hill Bluff. In the final analysis it seems productive therefore to restate the tentative findings by Jones and Hildebrandt (1990) to incorporate the results from the 2008 Cabrillo College excavations and the above analysis.

Given the above data, it seems reasonable to assert that the importation of obsidian at Sand Hill Bluff appears to have been generally uninterrupted from about 4000 YBP of the Early Period and likely transpired through cultural contact with secondary supplies rather than direct trade with groups in control of the obsidian sources. The dominance of Napa obsidian was notable throughout the period of obsidian use, fading only during the Late Period when material from other sources became more common. Late period trade affiliations with secondary supplies in the southern San Francisco Bay Area are indicated. Imported items consisted largely of late stage tools that were finished, retouched, and recycled at the site.

Part III: SJSUOL/Muwekma Ohlone Cultural Exchange Collaboration—A Proposal for the Future

Introduction

Communities of practice have been described as having both transformative potential and reproductive potential depending on institutional context (DePalma 2009). Through reproductive potential, a practice community perpetuates itself through any number of mechanisms organic to a functioning community. These include, for example, technical support for individual competency and improvement in practice, the communities shared energy and momentum, and the transfer of knowledge and legitimacy through such structures as the mentor-apprentice relationship (Lave 1982). As described above, Parts I and II of this project report are supportive of this aspect of the SJSUOL community of practice.

Transformative potential, on the other hand, is a generative element the makes possible "the emergence of dialogic relationships whose negotiation would serve to transform rather than reproduce teaching and research practice (DePalma 2009, 355). What is presumably transformed are undesirable paradigms and fossilized behaviors that work against the interests, goals, and development of the community. Rather than being a random process, I suggest that the transformative potential of communities of practice can be directed to address specific shortcomings within the practice environment. In this proposal, students and the Native American community would collaborate in a cultural exchange that undermines the divergent interests and lack of communication that are characteristics of the historically derived binary between the archeological research community and the Native American community (Weiss 2008; Thomas 2000; Leventhal et al. 1994) within the context of the SJSUOL community of practice and its greater institutional setting.

As indicated in Figure 1, the Native American community is explicitly included in the vision for a community of practice at the SJSUOL. In this context, the local expression of this large and diverse community will be through the Muwekma Ohlone Tribe of the San Francisco Bay Area. Other Ohlone people in the area are affiliated with the Esselen group. The inclusion of the Tribe recognizes the ongoing contribution to obsidian studies made possible by the Muwekma Ohlone Tribe's support for analysis of their cultural heritage sites as well as the fact that the Tribe, through its cultural resource management firm, Ohlone Family Consulting Services, has used obsidian hydration analysis in professional reports for many years. The Muwekma Ohlone have also stored a portion of their cultural materials at San Jose State University for many years.

It is further implied by the model in Figure 1 that there is both a transfer of knowledge from the SJSUOL, through research projects, to the local Native American community and a transfer of knowledge and support from the Native American community to the SJSUOL. The current proposal is to reify this part of the model by defining the details of these two communicative and connective elements and conducting the first instance of the actual exchange between these two groups. I argue that such a project will activate the transformative potential of communities of practice to challenge the normative view of the relationship between "researcher" and "researched" for all those within the SJSUOL community of practice.

Statement of Problem

The Native American Community

Prior to federal and state regulations to the contrary, the Native American community has often endured destructive analysis of their heritage sites and ancestral remains without their consent. Even under new regulations such as the Native American Graves and Repatriation Act (PL 101-601) and Tribal Consultation (Cal SB 18) and with consent, academic and cultural resource management (CRM) archeologists have rarely considered Native perspectives on research questions and excavation design, resulting in research of little value to Native American groups. This shortcoming is more acute given the dramatic proliferation of archeological investigations in the CRM era (1970 to present).

In the context of the SJSUOL, the Muwekma Ohlone Tribe of the San Francisco Bay Area has consented to destructive analysis on obsidian artifacts recovered from their traditional territory for many years. This is one of the primary reasons the obsidian laboratory at San Jose State became so productive in its earlier form. It has also been the case here, however, that the Tribe has received few tangible benefits from this analysis, including denial of their request for researchers to share findings in the form of finished reports. Wilson's 1995 compilation of hydration readings, for example, is important as a primary source of raw hydration data for the Bay Area but was neither contextual nor interpretive. As such, it was productive and contributory but not a "deliverable" in the sense of adding synthesized understanding to Muwekma Ohlone cultural history.

This proposal seeks to establish the structure and criteria needed to initiate student reporting on hydration projects to the Tribe that is both contextual and interpretive. By viewing this activity as an essential part of being a technician in the SJSUOL, we provide for the flow of tangible benefits to the Tribe concerning their cultural history.

The SJSUOL

To support ongoing interest in the SJSUOL and to attract new student hydration technicians, current students must actively promote the lab to incoming students. This was the motivation for the introductory hydration lecture I developed following my initial training in the hydration technique. Students in Introduction to Archaeology courses at SJSU and local community colleges are the appropriate audience for this lecture, as they will have several years to contribute to the operation of the lab should their interest lead to participation. The lecture, therefore, must be provocative and interesting. Both the lecture outline and the related PowerPoint images are included in.

To initiate this effort, I gave the obsidian hydration lecture three times during the 2010-2011 academic year. While reaction to the lecture has been generally favorable, data from post-lecture student evaluations indicate that new students to archaeology would find the lecture more interesting if it contained more information about the cultural significance and meaning of obsidian to Native American groups and how these groups made and used obsidian tools.

Specifically, 41 post-lecture student evaluations[3] show that students responding to the statement “The lecture would be more interesting if it included more information about the cultural significance and meaning of obsidian for Native American groups,” where the possible answers were ‘Strongly Agree,’ ‘Agree,’ ‘Neutral,’ ‘Disagree,’ and ‘Strongly Disagree,’ 54 percent chose ‘Agree’ or ‘Strongly Agree’ while only 19 percent chose ‘Disagree’ with 27 percent remaining neutral. Similarly, when asked about the inclusion of “more information about how Native Americans made and used obsidian tools,” 58 percent chose either ‘Strongly Agree’ or ‘Agree’ while 14 percent chose ‘Disagree’ with 27 percent indicating the neutral position. This contrasts with responses to the statement “The lecture would be more interesting if it included more technical and scientific information about obsidian and its physical properties.” For this statement, 15 percent of the students chose ‘Agree’ as their answer while 37 percent either disagreed or strongly disagreed. Thirty-nine (39) percent of students indicated a neutral response.

If only students who also indicated that they were currently or were planning to major in anthropology (n=19) are included, the responses for “more cultural significance and meaning” were 58 percent ‘Agree’ or ‘Strongly Agree,’ 10 percent ‘Disagree,’ and 32 percent ‘Neutral’. Regarding more information about “how Native Americans made and used obsidian tools,” 74 percent chose ‘Agree’ or ‘Strongly Agree,’ 5 percent ‘Disagree,’ and 21 percent ‘Neutral.’ Responses to the statement about more technical and scientific information about obsidian were 16 percent ‘Agree,’ 32 percent ‘Disagree’ or ‘Strongly Disagree’ with 53 percent remaining neutral.

While the lecture could be infused with greater cultural content by turning exclusively to secondary sources, such a solution would forgo the opportunity to initiate with the local Native community the kind of dialogue that might lead to transformations for the practice of obsidian studies at the SJSUOL. The solution proposed here is to create a process through which the modern Native American community contributes directly to the main recruiting tool used by the SJSUOL to generate new interest. Contributions focused on the intersection of Muwekma Ohlone culture and language with the many uses and meanings of obsidian will link the analytic potential of obsidian hydration with local Native life. Native Americans will in their own words contribute Tribal meaning regarding what their role should be and what they want from the process. In doing so, we challenge existing notions concerning divergent interests between archaeological research and Native Americans and encourage the recognition among young students that the contemporary Native American perspective co-occurs with the archaeological perspective.

Significance of the Project

For all the various individuals and groups involved with the SJSJOL, succeeding in establishing a resilient community of practice that includes the contemporary Native American perspective would have several benefits. Future anthropology students will benefit from an active laboratory setting in which they can acquire new technical skills while gaining organizational acumen through helping to operate and manage laboratory functions. Students will have a rich source of projects that they can use to complete undergraduate and graduate requirements and gain valuable presentation experience. As part of a community of practice, students will gain legitimacy within the archaeological community and improve their job prospects after they graduate by possessing an enhanced understanding a widely use analytical tool and the cultural competency to use it effectively in collaboration with Native American groups. A community of practice that is collaborative with the local Native community will strengthen cultural competency and anthropological understanding among these students. The success of an inclusive community of practice may also serve as a helpful model for other related groups in the laboratory and their students.

The project will potentially increase the flow of culturally informative information to the Muwekma Ohlone Tribe of the San Francisco Bay Area through student presentations of original research. This research can assist the Tribe in exploring its own historical complexity and in furthering important tribal initiatives, such as the effort to once again obtain federal recognition. The information can also add to and refine knowledge that supports cultural resource management decisions effecting protection and preservation of heritage sites.

Since Native culture and language has few relevant opportunities to exist side by side with American culture and the English language, the Tribe will benefit from having another framework for cultural expression. Through the inclusion of the contemporary Native American cultural contributions in the obsidian hydration lecture to young students, the project supports Muwekma Ohlone cultural and language revival efforts.

The proposed project is intended to have implication for the greater discipline of applied anthropology as well. Whereas the reproductive potential of communities of practice has received much attention, the transformative potential has not been as widely studied or elaborated theoretically, and few case studies have been documented (DePalma 2009). As a result of the proposed project, it should be possible to evaluate the transformative potential of communities of practice through a case study of the SJSJUOL perhaps five or ten years from now. Such a project would contribute to the theoretical and practical understanding of communities of practice and provide some future student with a very interesting project. The evaluation of the program will involve further collaboration with the Tribe and should also be a source of cultural exchange experience for everyone in the community of practice.

Methods

Since this project is intended for some time in the future, a detailed description of the methods is premature. A final research design should be sensitive to conditions as they will exist at the time of the project and, therefore, that design will itself be an integral part of the overall project. Even with the uncertainty, however, some general methodological concepts can serve as an initial outline for planning the project.

In the initial stages of the project, the Muwekma Ohlone Tribe of the San Francisco Bay Area will need to be contacted to invite them to participate as partners in the cultural exchange collaboration. As of this writing, the Tribe has only been informed of a student initiated project focusing on Muwekma Ohlone culture and language in the context of SJSU obsidian studies. This brief notification was done through Alan Leventhal, Ethnohistorian, and future contact can also be made in this manner. The Tribe responded favorably to the idea for the project, requesting continued involvement of student tribal members were student interest permits.

The methods used to accomplish the initial presentation of obsidian results to the Tribe will of course depend on the specific type of research that is undertaken. Site reports, regional or inter-site comparisons, cultural chronology studies are all possible in the SJSUOL, and much will depend on individual student interests and the particular collection of obsidian a student chooses to study. Generally, this process will start with a research proposal to an anthropology department faculty member in the context of a structured requirement such as ANTH 280, ANTH 298, or ANTH 299. This could also be done in an undergraduate class as approved by the faculty.

Methods of presentation to the Tribe will also depend on the results of consultation and the Tribes perspective regarding a preferred framework for the presentation. For example, it must be decided if the presentations will be made to the general Tribal Council or to a subcommittee designated for that purpose. The time, location, and length of the presentation are still other considerations.

Interaction with the Tribe could take several forms. It might be useful to view this effort as participatory action research (PAR) to achieve "a joint decision to engage in collective action that leads to a useful solution that benefits the people involved" or "the building of alliances between researchers and participants in the planning, implementation, and dissemination of the research process" (McIntyre 2008, 1). In such a PAR setting, the Tribe might designates tribal member-liaisons to work with the student on details of the collaboration. Ideally, liaisons functioning in this role would be both tribal members and SJSU students. Alternatively, the Tribe might simply ask the student for a short proposal to address the Tribal Council at a general meeting or a designated sub-group.

Regarding the flow of cultural knowledge from the Native American community to the SJSUOL, it seems obvious that some sample method will be needed to facilitate the contribution of the nearly 600 Muwekma Ohlone Tribal members. Such a sample might be part of an empowerment evaluation of the current obsidian hydration lecture, thus contributing their cultural knowledge through developing a joint vision and unifying purpose, critiquing the existing strengths and weaknesses of the lecture, and establishing strategies for accomplishing future goals and objectives (Fetterman 2001).

Ethnographic methods should also be considered. The Tribe's standing language committee may have knowledge of certain individuals with specific memories or some fluency in the Native Muwekma Ohlone language that could be a rich source of cultural and linguistic information relative to obsidian. Such individuals might value the opportunity to share their knowledge through semi-structured and structured interviews.

Conclusion

It is important to remember that while this project will be the first instance of many of both the student presentations to the Tribe and the collaboration with the Tribe on their cultural perspective; it should be the long-term goal to continue with these activities in the future. Regarding student presentations, it might be desirable to establish a biannual, once per year, or once per semester pattern that both student and the Tribe can anticipate and plan for well in advance. Of course, much will depend on how many students are active in the SJSUOL at any given time and the status of their various projects. Similarly, while the student collaboration with the Tribe on cultural perspective will be a major task the first time, it might be possible for future interaction to be through a designated group such as the Muwekma Language Committee annually or as needs arise.

In any case, as these new social frames became normative, we can expect that transformations will occur to the benefit of everyone involved in the SJSUOL community of practice. We can expect that our student will be increasingly likely to consider the development of research questions and project design as a multi-vocal exercise in which the archeological perspective is one of several considerations. Further, it should be that the Native American cultural component in such research is fundamental to good research design and professional archaeology.

Notes

[1]Distilled water is the preferred blade lubricant, as this prevents build-up of impurities in the reservoir and extends the life of the blades.

[2]The blades for the saw are 0.004 inches thick and 4 inches in diameter. Changing the blade requires a 9/16 inches crescent wrench or an adjustable wrench and a 7/32 inches hex key. Wenric's Jewelry and Supplies is located in south central San Jose near the Westfield Oakridge Mall. This store sells lapidary equipment including saw blades, grit, epoxy, and oil lubricant. They also service gem saws should the need arise.

[3]I have given the obsidian hydration lecture to three "Introduction of Archaeology" classes—once in the fall 2010 term at SJSU and twice in the spring 2011 term at both SJSU and Cabrillo College. The 41 student evaluation responses are from the spring 2011 presentations at Cabrillo College (n=25) and SJSU (n=16).

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Appendix A

Obsidian Hydration: An Introduction to an Archaeological Technique

This lecture was developed following a graduate internship undertaken to learn obsidian hydration laboratory techniques during the summer of 2010. Like many specialized methods, knowledge of obsidian hydration is quite limited beyond professional archaeologists, and the topic is rarely covered in introductory anthropology and archaeology courses at junior colleges and universities. Thus, this short lecture (about one hour) is intended to provide an overview of the theory, method, and application of obsidian hydration for such courses. Following the presentation, students should be able to understand the concepts behind the technique and to recognize how obsidian hydration data contribute to archaeological site reports and other studies they may encounter during their studies.

The lecture is also intended as recruiting tool to generate interest in the San Jose State University Obsidian Laboratory (SJSUOL). This lab is within the Anthropology Department and offers students a chance to learn obsidian hydration and to participate in real archaeological research.

Introduction

1. **Introduction and overview of general purpose of anthropology/archaeology**

    a. Questions about purpose and responsibility
        i. What do archaeologists really do? (Find old things, dig holes, make History Channel documentaries, etc.)
        ii. Why do they do those things? (To learn, educate others, become famous)
        iii. Why are those things important?

    "The coolest thing about archaeology is ***digging things out of the ground*** *(1) and* ***teaching people*** *(2) about them"*
    Dustin McKenzie

        1. Investigating the past
        2. Passing on knowledge to others

b. OH is one of many analytical tools used to accomplish this purpose
    i. What are some other tools?
        1. Radiocarbon dating
        2. Analysis of bones, rocks, charcoal, soil, etc.
        3. Ethnography
        4. Categorization and comparison
        5. Reconstructing past environments, cultures, life ways, etc.
        6. **Obsidian hydration?**

2. **What is obsidian?** (provide sample to students)
    a. Appearance and physical properties
        i. Shinny, dark, brittle, sharp,
    b. Origin of obsidian (Monroe & Wicander, 2001)
        i. **Igneous** rock (formed from cooling and crystallizing of magma)
        ii. **Extrusive** (deposited on the surface, verses intrusive—within the earth)
        iii. Rapid cooling produces homogenous mass without mineral nuclei and therefore without crystallization—volcanic glass
        iv. Tends to have high silica content (felsic)
        v. Perlite forms from the hydration of obsidian

    c. Location of remnant obsidian (distribute map of California obsidian sources)
        i. Tends to be in small outcroppings near previously active volcanic zones
        ii. Each location has identifiable chemical signature (**obsidian sourcing**)
            1. Each magma path to the surface is different
            2. Mixing with other substances affects composition/signature
                a. Mass spectrometry
                b. Net element counts

3. **Uses of obsidian for prehistoric people**

    a. Knifes, points, ornamentation, ceremonial objects
        i. Physical properties exploited by humans
            1. Predictable **conchoidal** fracturing
                a. Cone shaped distribution of force
                b. Similar to modern glass
            2. Razor sharp edge

3. Re-sharpening
4. Can take a high polish
5. Forms in many colors and shades

b. Trade commodity—from those who had much to those who had little or none
c. **Prestige** item

Theory and Method

1. **Discovery of diffusion reaction in obsidian (Friedman & Smith, 1960)**

a. Friedman and Smith were not anthropologist, they were geologists
   i. Discovered the fact they obsidian absorbed water on **margins** (surface exposed to the atmosphere) while studying thin sections for geologic purposes
      1. Diffusion reaction
      2. Water molecules wiggle their way between rock molecules
   ii. Tested obsidian artifacts of known age for correlation between time and hydration band thickness
   iii. Also determined the two most significant variables in addition to time
      1. Geochemical composition (closely related to source)
      2. Temperature
         a. Hydration rate increases with temperature
         b. Temperature is least significant (@4-6 % contribution per degree of temperature difference)
   iv. Recommended the process as dating tool for archaeology

b. Many others have refined and tested basic concepts since 1960

2. **Method**

a. Cut the thin section
   i. Must cut at right angles to the margin (chipped or worked surface)
   ii. Use of a **gem saw** is required

b. Mount the thin section on slide
   i. Mount specimen in balsam medium with low melting point

   ii. Heat provided by hot plate
   iii. First side is ground with **grit** (loose sand paper)
   iv. Specimen is turned and remounted
   v. Opposite side ground again to a thickness of about 0.003 inches
   vi. Allow to dry
   vii. Fix slide cover over the specimen and the medium permanently

c. View slide under magnification (400X)
   i. Find hydration band where it exists
      1. Band can be similar to the color of obsidian specimen
      2. Band can be degraded by erosion of obsidian surface
      3. Band can be extremely thin
      4. Band can be nonexistent
      5. Leading edge of band (**hydration front**) can be diffuse
      6. Use of polarized light and color filters can be helpful
   ii. Measure band width with micrometer (**micron = 1/1000 of millimeter**)
      1. Measurement is between the margin and the hydration front
      2. Measurement is taken on line perpendicular to margin
      3. Typical band measurement is between 2 to 7 microns
      4. Record measurement with care to insure integrity of data

3. Application of technique

a. Relative dating
   i. Law of Superposition
   ii. Principal of association
b. Absolute dating
   i. Considerably less reliable
   ii. Unknown influences remain to be investigated
   iii. When used, raw data is manipulated to account for two variables
      1. Source of the obsidian
      2. Mean temperature of deposition location (largely speculative)
   iv. Principal of association

c. Comparative Parameter
   i. Inter-site and inter-region studies
   ii. **Diachronic** intra-site studies
   iii. **Synchronic** source analysis

   iv. **Triangulation** with other data

4. **Ethical Issues**

   a. Obsidian hydration is a destructive procedure
      i. Funerary items usually not available for analysis per tribal wishes
      ii. High quality type-artifacts usually not available for analysis
         1. Such artifacts could be ceremonial per tribal interpretation
         2. Should be preserved intact for comparative study per some archaeologists
      iii. **Debitage** and artifact fragments typically can be subjected to destructive analysis

   b. Other issues?