Obsidian Hydration: the Squaw Creek Site Revisited

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Excavations at the Squaw Creek site, Sha-475, yielded a substantial collection of flaked and ground stone artifacts representing more than 7,000 years of human occupation. Obsidian hydration analysis of a large collection of projectile points from this site revealed an unusual pattern of hydration readings, leading to skepticism regarding the utility of obsidian hydration for relative dating of this assemblage. A more recent examination of hydration readings for a large sample of obsidian debitage from this site provides the same peculiar pattern, one that appears to contradict the stratigraphic observations and radiocarbon data. While a number of factors may have contributed to this phenomenon, changes in the hydration rate caused by natural influences appears to have played a key role in creating the observed hydration pattern. Diachronic changes in the rate of obsidian hydration, as suggested by the Squaw Creek material, may have broader implications for hydration studies in the larger Klamath Mountains area.

It is because of the pioneering work and teachings of dedicated professors, such as Jerald Johnson, that I now have a career in archaeology and a particular interest in the prehistory of northeastern California. My interest in archaeology goes back to my childhood in Tehama County, with wanderings throughout Dye Creek Ranch, Mill Creek, Battle Creek, and the Mt. Lassen area. As a teenager, I remember learning about Jerald Johnson's field school at Dye Creek Ranch, and becoming aware of the unique prehistory of that area. While I did not have an opportunity to work with Sacramento State University, at the age of 14, I was fortunate enough to be included in archaeological investigations conducted by Shasta Community College. Included among these projects was the final field school at the Squaw Creek site, Sha-475. Under the guidance of Eileen Spencer, Elaine Sundahl, Ed Clewett, Dick Philpott, and others, I was given my first opportunity to participate in a controlled excavation, and remember the excitement of climbing into deep, damp excavation units above Fenders Ferry Road and observing the unusual widestem projectile points and other artifacts recovered from the site. Years later, when pondering topics for a thesis, I decided to explore the lithic technology of the Squaw Creek site, realizing that this site was known for its deeply stratified deposit and rich variety of flaked stone artifacts. What better site exists in this region for exploring changes in lithic technology through time?

CA-SHA-475

Site Sha-475 is situated within the Squaw Creek watershed, a tributary of the Pit River arm of Shasta Lake (Figure 1). This midden deposit, extending to depths of 13.5 feet (4 m), was investigated by Shasta College field archaeology classes from 1971 through 1982, resulting in the recovery of a large sample of cultural materials. Based on six radiocarbon dates, including four from cultural features, three broad cultural components spanning more than 7,000 years of prehistory were identified. The earliest site occupation, designated Component I, is characterized by the use of large, robust, widestem projectile points, the use of atlatl weights, the predominant use of Medicine Lake Highland obsidian, and the use of manos and metates to process food. Based on radiocarbon dates (Table 1), this component has been placed within the period from 7550 to 4950 B.P. Component II represents the most intensive occupation of the site, and dates from 4950 to 1450 B.P. This second component is characterized by the use of contracting stem and leaf-shaped projectile points, unifaces, broad tipped drills or gravers, cobble spalls, acorn anvils, and the mano and metate. Large serrated points appear early in Component II, while corner-notched forms appear late. Component III is characterized by the Gunther Barbed point, side- and corner-notched points, thin drills, manos, metates, pestles, and large quantities of fire-cracked rock. This last prehistoric component persisted from 1450 to 100 years B.P. Both Medicine Lake Highland and Tuscan obsidians were utilized during components II and III (Clewett and Sundahl 1983:80-82).

Obsidian Hydration Dating

Armed with the knowledge of multiple components of great antiquity at the Squaw Creek site, my first order of business was to conduct analyses

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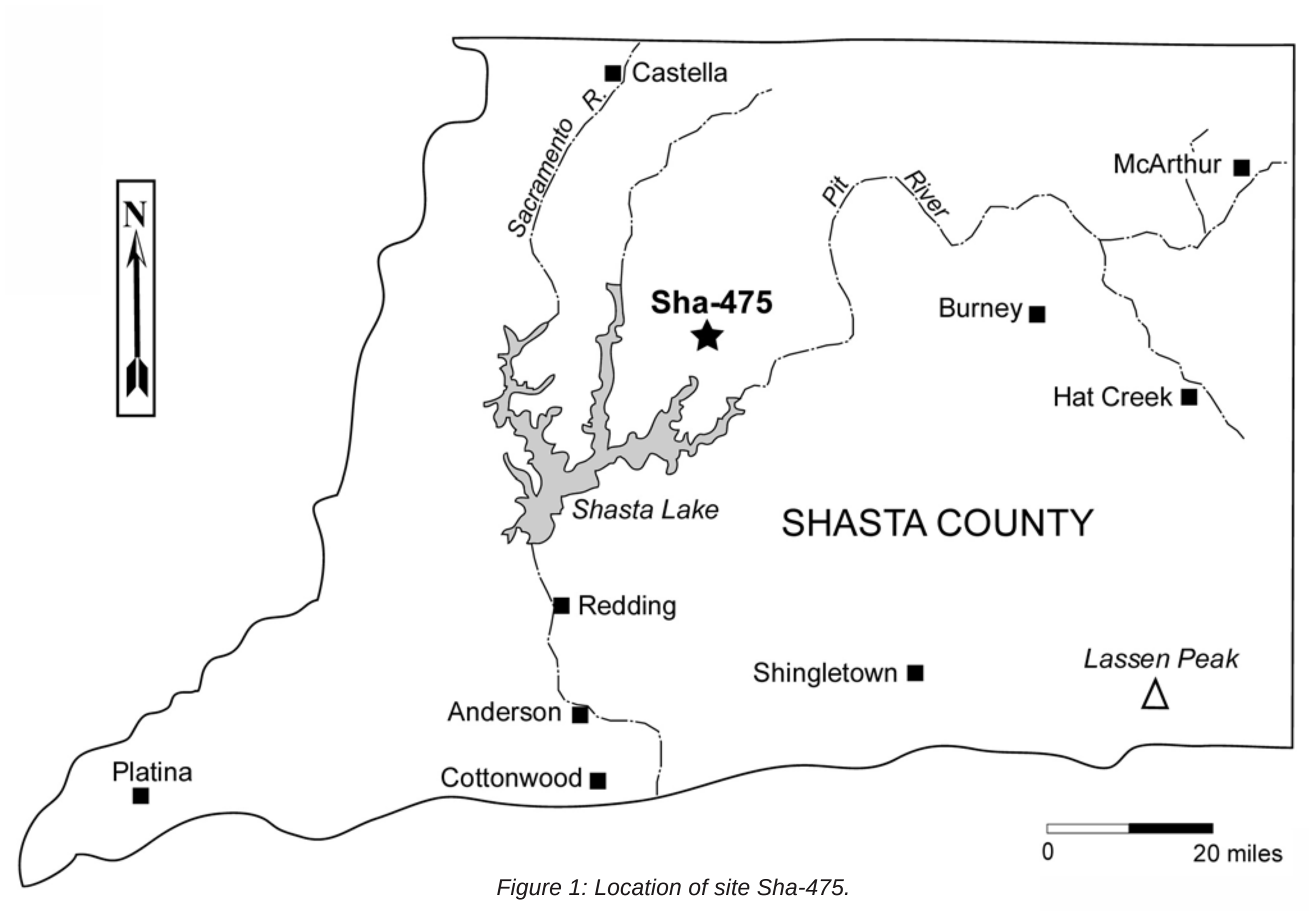

Figure 1: Location of site Sha-475.

of flaked stone debitage, including basic attempts to identify changes in raw material usage through time, technological flake types, average flake size, etc. Before this first task could be accomplished, it was necessary to gain temporal control for levels within some of the deepest excavation units, and this could be achieved by pairing obsidian hydration data with radiocarbon dates.

Obsidian hydration dating of a large sample of projectile points from the Squaw Creek site had already been accomplished, and had yielded mixed results (Clewett and Sundahl 1983:82; Sundahl 1992:33). Small projectile points representing

Table 1: Uncalibrated radiocarbon dates from Sha-475.

Lab Number	Years B.P.	Material
GaK-4219	1110 ± 390	pine bark from fire hearth
I-13, 482	1650 ± 120	scattered charcoal fragments
GaK-4855	4000 ± 95	pinecone scales in fire pit ash deposit
GaK-3818	6530 ± 300	charcoal fragments beneath millingstone
I-13, 481	6870 ± 210	charcoal from fire pit
GaK-6885	7580 ± 230	scattered charcoal fragments

Component III yielded the smallest hydration readings, as expected. However, readings obtained from the two earlier components appeared mixed, as underscored by a decrease in hydration values for objects found below the 4.0-foot level. Clewett and Sundahl (1983:82) offered four possible explanations for this phenomenon, including: (1) mixing of site stratigraphy; (2) rapid accumulation of artifacts of nearly the same age below 4.0 feet in depth; (3) inaccurate obsidian hydration measurement; and (4) changes in hydration rate caused by other influences. Additional hydration analysis proved the initial study to be accurate, while there was little evidence found of significant stratigraphic mixing. Also, correlation of radiocarbon dates and artifact types by depth did not support the idea of rapid artifact accumulation. It was determined that some other factors were affecting the rate of hydration (Clewett and Sundahl 1983).

In later years, Henn and Sundahl (1988) addressed the issue of obsidian hydration dating at Squaw Creek. The results of this study also revealed that obsidian from Component I was apparently younger than material from Component II, although the Component I material occurred stratigraphically lower. Henn and Sundahl (1988) presented several possible explanations for this hydration pattern, including: (1) curation or re-use of older projectile points; (2) misidentification of components; and (3) chemical composition or temperature influences on hydration rate.

To test the idea that older projectile point forms were curated over long periods of time, or recycled, Henn and Sundahl (1988) submitted a sample of unmodified obsidian flakes from the three components for hydration analysis. The results of the new analysis revealed the same pattern as that observed for the projectile points, suggesting that curation was not a factor. They also tested the idea that mixing of earlier components resulted in mixed hydration values. Statistical analysis of projectile point provenience for segregated units within the deepest cultural deposit revealed a significant vertical separation of point types (Henn and Sundahl 1988). Statistical analysis also supported the fact that while hallmarks of components I and II are stratigraphically discrete, there is no difference in obsidian hydration values between the two components.

Realizing that there was a problem with earlier obsidian hydration dating for the Squaw Creek site, I brought it upon myself to conduct additional hydration studies of a larger sample of unmodified waste flakes from the deeper portion of the site, particularly within the area that yielded the earlier radiocarbon dates, as well as the complete atlatl weight. I intentionally chose material visually identifiable as Medicine Lake Highland obsidian, since such material appears to hydrate in a uniform manner (Cleland 1997:71). With the help and expertise of Kathleen Hull, I cut nearly 300 obsidian flakes from several units, with an attempt to gain at least five or more hydration readings for each level within the sampled units. To date, readings have been provided for two-thirds of the sample, or 188 specimens.

One hundred twenty-one hydration readings were obtained for unit N55-E141, a 5-x-5 foot unit that reached bedrock at a depth of 9.0 feet. This sample of hydration values revealed the same pattern identified in earlier investigations of the site (Figure 2). Excellent results were obtained for the obsidian recovered from the upper 4.0 feet of the unit, representing the past 4,000 years (Late Holocene) based on a radiocarbon date from an ash lens in the 3.5-4.0 foot level of a contiguous unit. However, below the 4.0-foot level, the hydration readings consistently become smaller, with the mean hydration decreasing from 5.0 microns at the 4.0-4.5 foot level to 3.6 microns at the 7.0-7.5 foot level. Below 7.0 feet, readings averaged between 3.6 to 3.8 microns. An uncalibrated radiocarbon date of 7580 ± 230 (GaK-6885; wood charcoal) was obtained from the 7.5-8.0-foot level of a contiguous unit (Clewett and Sundahl 1983:72), indicating that cultural materials found below 7.5 feet may represent Early Holocene occupations.

Although my main concern with the Squaw Creek site was to conduct an analysis of flaked stone to identify potential changes in lithic reduction technology through time, I became sidetracked by the apparent discrepancy between radiocarbon dates and obsidian hydration readings. Recent literature suggests that a variety of factors may have an influence upon the rate of hydration within a particular site (Beck and Jones 1994; Hull 2001). Factors that are now recognized as influencing the rate of hydration include: (1) chemical composition of obsidian; (2) temperature of the hydrating environment; and (3) relative humidity of the hydrating environment. It is recognized that within obsidian source areas or flows, a variety of geochemical types may occur (Beck and Jones 1994; Hughes 1991; Hughes and Smith 1993). Henn and Sundahl (1988) considered intra-source variability of chemical composition as a potential factor for the Squaw Creek anomaly. While numerous types and qualities of Tuscan obsidian have been identified (Hamusek-McGann 1993), few distinct groups of Medicine Lake Highland obsidian have been noted (Hughes 1982, 1986). As stated above, previous investigations have shown such material to hydrate in a uniform manner (Cleland 1997). In addition, the consistent increase in hydration rim width with increased depth for the upper 4.0 feet of the current study unit also suggests a uniform hydration rate. Although the material below 4.0 feet does not appear to have hydrated in a uniform manner, it is unlikely that it would require 4,000 years to pass before the intra-source chemical variability manifests itself in the archaeological record.

It is more likely that discrepancies in effective hydration temperature (EHT) and humidity have resulted in the hydration pattern observed at the Squaw Creek site. Learning the thermal history of an obsidian artifact is perhaps the most difficult problem in obsidian hydration dating (Beck and Jones 1994:51). One must control for average annual air temperature, average annual soil temperature, and changes in temperature by depth. Many factors may affect soil temperature, such as soil color and moisture, chemical composition of soil, slope and aspect, vegetation cover, snow cover, and others. It is believed that soil temperature decreases with increased depth, with the disparity between temperatures becoming smaller as depth increases (Beck and Jones 1994:51). While temperature differences may be most pronounced

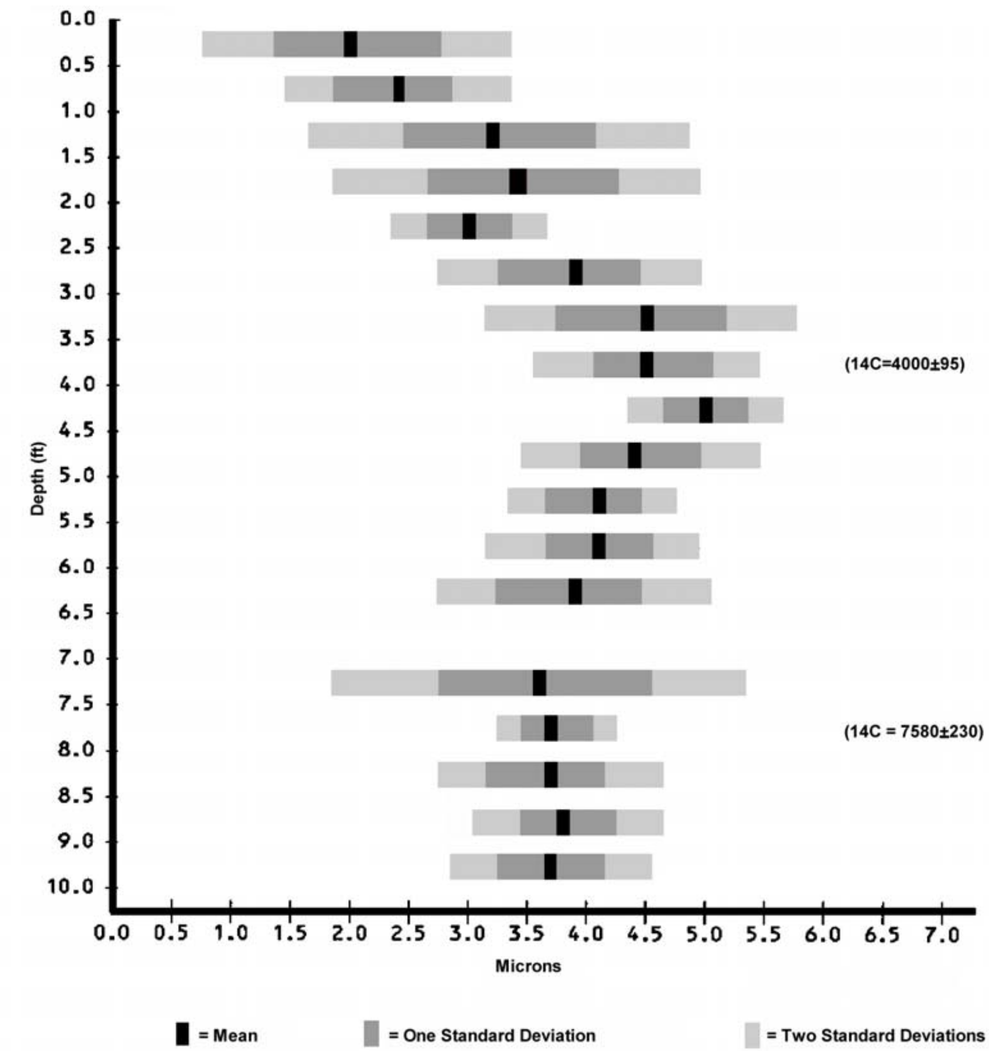

Figure 2: Obsidian hydration readings by depth for Unit N55-E141 debitage, Sha-475 (n=112).

within the upper several feet of the cultural deposit at Sha-475, the differences in subsurface temperature is likely negligible within the greater depths of components I and II.

It has long been recognized that climatic changes have occurred during the Holocene, or past 10,000 years, significant enough to have resulted in extensive reorganization of ecosystems due to changes in both temperature and precipitation (Spaulding 1997). Following the last glacial age, the Early Holocene, prior to 7500 B.P., witnessed increasingly dry conditions and warm temperatures within the Great Basin, Sierra Nevada, and North Coast Range. Within the North Coast Range, Early Holocene temperatures may have been 1.4 - 2.1°C above those of the present (Adam and West 1983; Adam 1988; Spaulding 1997:50). While temperatures continued to rise within the west slopes of the North Coast Range during the Middle Holocene, evidence from the Trinity Alps and Sierra Nevada show a decrease and amelioration of temperature during the Middle Holocene, after 7500 B.P. This included an increase in effective moisture as early as 7000-6000 B.P. in the Sierra Nevada. Increased precipitation and a decline in temperatures continued into the Late Holocene, occurring shortly before 3500 B.P. in the Trinity Alps (Spaulding 1997:50-51). Afterwards, modern conditions continued throughout the Late Holocene.

This scenario of Holocene climatic change may explain to some degree the obsidian hydration record at Squaw Creek, working particularly well for Component III times, but is at odds with other evidence. If those materials above 4.0 feet represent a Component III, or Late Holocene, occupation, then the materials from that component have been subjected to more-or-less modern environmental conditions. The uniform hydration profile above 4.0 feet, showing a steady increase in hydration readings with depth, suggests that such conditions were stable, or perhaps a slight cooling trend occurred. Component II materials, presumably dating from 4950-1450 B.P., date primarily to the Late Holocene with some overlap with the Middle Holocene, and should have also been subjected to fairly modern conditions. However, the decreased hydration readings with depth suggest a steady increase of temperatures during Component II times, or during the Middle-to-Late Holocene transition. Those obsidian artifacts grouped within Component I, dating roughly from 7500-5000 B.P. fall within the Middle Holocene, and the consistent hydration readings around 3.6-3.8 microns suggest a steady increase in temperatures during that time. It may also represent a single, relatively short occupation of the site with rapid deposition of sediments. All of the above scenarios are contingent upon the assumption that temperature and humidity changes were significant enough to affect the hydration process.

The hydration profile for Sha-475 may also result from post-depositional processes such as rapid burial, erosion, or fire. However, the uniform nature of the hydration for both tools and debitage, and generally tight clusters of readings, suggest that the decrease with depth did not result from the effects of fire, nor from random erosion and weathering of artifacts. It may be that Component I materials were buried rather quickly after being deposited, as colluvium was carried downslope, perhaps during a lengthy period of unstable climatic conditions. However, such an explanation remains to be tested.

Conclusion

What does all this tell us about obsidian hydration dating, and about the age of the cultural deposit at Squaw Creek? Given the six radiocarbon dates, including four dates from documented features, and the apparent vertical separation of certain artifact types, the proposed age of the deeply stratified Squaw Creek site remains reliable. This indicates that for whatever reason, obsidian hydration works for those materials deposited within the last 4000 years B.P., with a decreased hydration rate or process for those material deposited before 4000 B.P., or found more than 4.0 feet deep in the deposit at unit N55-E141. The immediate significance of this pattern of hydration readings is that it has brought attention to the fact that the hydration process does not always work in the manner to which we may be accustomed, or in the manner we might expect. For myself, it brings into question the results of other projects in the vicinity of Squaw Creek and in the Klamath Mountains.

For example, extensive investigations within the Sacramento River Canyon (Basgall and Hildebrandt 1989; Raven *et al*. 1984), located 25 km west of Squaw Creek, revealed similar assemblages of artifacts representing at least 5,300 years of continual occupation, with limited evidence of earlier occupations. At Sacramento River Canyon, a limited number of widestem projectile points was recovered, and obsidian hydration readings for these artifacts also tend to be relatively small, apparently overlapping in time with corner-notched and contracting stem types (Basgall and Hildebrandt 1989:178). It may be that such items do in fact pre-date the other point forms, but due to a disparity in the hydration rate or process during the Middle-to-Late Holocene, they appear to overlap significantly in time with the later forms. It may also be that the considerable temporal overlap between Pollard Flat Phase and Vollmers Phase materials (Basgall and Hildebrandt 1989:433) may in part be a result of a slower rate of hydration that occurred during a portion of the Middle-to-Late Holocene, a process caused by natural environmental factors. Basgall and Hildebrandt (1989:435) point out a lack of temporal overlap within the Squaw Creek assemblage as a potential problem of the Squaw Creek sequence, with "great ramifications for both culture history and culture process." However, data from the Squaw Creek site point to changes in hydration rate through time, suggesting that the Sacramento River Canyon sequence contains some measure of artificial temporal overlap, one not as great as perceived. Since this sequence relies to a great extent on the conversion of obsidian hydration values to define phases, any overlap in hydration readings caused by changes the hydration process prior to 4000 B.P. may result in an apparent temporal overlap between discrete temporal assemblages.

Obviously, more work at the Squaw Creek site, or sites containing similar stratified deposits, may help to resolve the issue of overlapping obsidian hydration values for apparently discrete artifact assemblages. The placement of temperature probes and a more detailed report of site stratigraphy and geomorphology at the Squaw Creek site may aid in this endeavor. In the meantime, I must rely on the radiocarbon record to provide the relative age of cultural materials within the Squaw Creek site, particularly those materials deposited before the Late Holocene.

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