Obsidian studies and Baja California's prehistory

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Abstract

Obsidian, the natural volcanic glass that occurs at scattered locations throughout western North America, has particular significance for Baja California archaeologists in two respects. The first is based on the potential to match archaeologically recovered specimens with their geological source locations. From spatial patterns in the distribution of source-identified obsidian artifacts, researchers are now able to begin testing several hypotheses about prehistoric patterns of mobility, exchange, and cultural isolation. The second value of obsidian is chronological. Flaked obsidian surfaces absorb water, and the microscopic hydration bands that are thus formed grow thicker with the passage of time. A beginning has been made by measuring hydration bands on archaeological specimens, but the interpretation of these readings is still in its infancy. Some preliminary conclusions about prehistoric Baja California based on obsidian sourcing and hydration are discussed, and strategies for the more effective use of this evidence are suggested.

Archaeological obsidian studies in Baja California are still in a very early stage of their development. It may be worthwhile to take a look at what work has been accomplished so far, what this has told us about the peninsula's prehistory, and what directions this research might profitably take in the near future.

Two basic types of analyses are discussed here. The first consists of identifying geological source areas for obsidian and matching archaeological specimens with their geological sources through chemical characterization, usually by means of x-ray fluorescence (XRF). The second involves measuring the depth of hydration on flaked obsidian surfaces, which serves as a chronometric tool. Of the two techniques, sourcing has made the more substantial contribution up to the present, while hydration studies are only now approaching a take-off phase.

The data

Some of the information generated by Baja California obsidian studies has been published, but much of it remains buried in technical reports. The data that are discussed in this paper have been summarized in table form and are now available on the bajacalifology webpage.

The archaeologists who have conducted these studies deserve credit for their important pioneering contributions. Project archaeologists whose studies have generated obsidian data include Eric W. Ritter, Justin R. Hyland, María de la Luz Gutiérrez, Patricia Aceves, Jerry D. Moore, Matthew R. Des Lauriers, and Clement W. Meighan. In performing the technical analyses, the XRF work of M. Steven Shackley has been especially noteworthy. Other valuable contributions in sourcing or hydration measurement have come from Paul D. Bouey, Tim

Figure 1. Obsidian sources in Baja California.

Carpenter, Kathleen Davis, Thomas L. Jackson, Jerome H. King, and Lisa Swillinger.

Obsidian sources in Baja California

Studies so far have identified at least eight locations in Baja California with geological deposits of obsidian that were exploited prehistorically (Figure 1). These include, from north to south, San Felipe, Arroyo Matomí, Puerto el Parral, Bahía San Luis Gonzaga, Isla Ángel de la Guarda, Ensenada del Pescador, Valle de Azufre, and Punta Mangles (Banks 1971; Bouey 1984; Douglas 1981; Gutiérrez and Hyland 2002; Hyland 1997; Hyland and Gutiérrez 1995; Moore 2001; Ritter 1979; Ritter and Payen 1992; Shackley 1994, 1995, 1997, 1998a, 1998b, 2004a; Shackley et al. 1996; www.swxrflab.net). Valle de Azufre contains particularly high-quality glass that was intensively quarried prehistorically and dominated obsidian use throughout most of the central part of the peninsula. Glass from Isla Ángel de la Guarda was used fairly extensively in the area around Bahía de los Ángeles and San Borja. Puerto el Parral supplied most of the obsidian that has been reported from the west coast between San Quintín and El Rosario. The other sources are still poorly documented, and some of them may have seen only minor prehistoric use.

XRF studies have been used to measure the frequencies of selected chemical elements within the obsidian -- most commonly titanium, manganese, iron, rubidium, strontium, yttrium, zirconium, and niobium -- and to match archaeological specimens with their probable geological sources based on similarities in those frequencies. In addition to the eight geological sources mentioned above, chemical signatures have pointed to the existence of at least six additional sources whose locations are not known at present. Archaeological specimens of most of these obsidian types have been found primarily at sites in the vicinity of Bahía de los Ángeles. One of these unknowns, in particular, seems to have been extensively used in north-central Baja California, along with obsidian from Isla Ángel de la Guarda. Discovering the locations of these sources will be an interesting challenge for field researchers over the next few years. It is possible that the locations, when they become known, will have something of interest to tell us

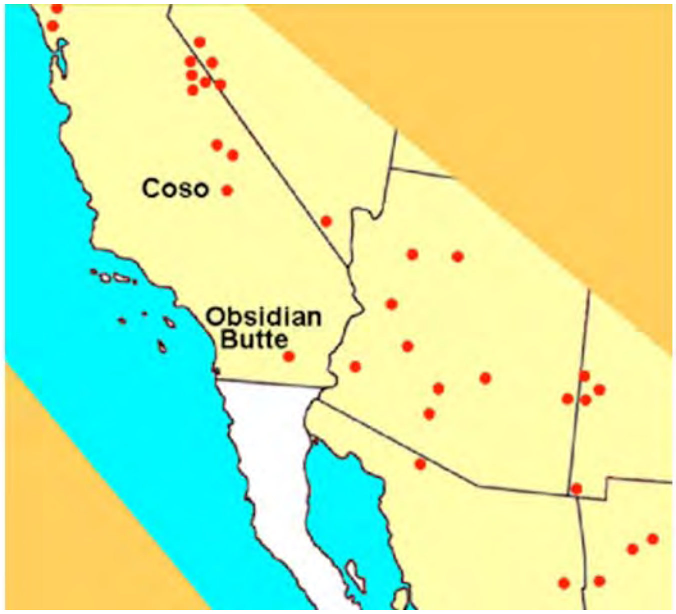

Figure 2. Additional obsidian sources outside Baja California.

about prehistoric settlement and mobility within the region.

In the Frontera region of northernmost Baja California, no substantial obsidian studies have been reported as yet. When such studies are done, it seems a safe bet that they will confirm the presence of material coming from sources located beyond the borders of Baja California (Figure 2). Obsidian Butte, 55 km north of the border in Imperial Valley, was the predominant obsidian source represented at late prehistoric sites in southernmost California (Hughes and True 1985), and its range can be expected to have extended farther south, into Baja California. The more distant Coso Volcanic Fields source, lying east of the Sierra Nevada and about 400 km north of the international border, is also represented with fair frequency in southernmost California, and it is likely to be found in Baja California as well. Many additional obsidian sources are known in California, Nevada, Arizona, and Sonora, and links with Baja California for some of these sources are possible (Hughes and Bennyhoff 1986; Shackley 1988).

The most important research contribution that comes from obsidian sourcing studies may lie in what they reveal about prehistoric patterns of mobility and exchange in Baja California. One variable of interest is the maximum geographical ranges that are documented for material from known sources (Figure 3). Valle de Azufre obsidian has been found in the area east of Bahía de los Ángeles (200 km distant from the source), at Laguna Manuela (160 km), Isla Cedros (250 km), Bahía Asunción (180 km), Bahía de la Concepción (120 km), and San Javier (210 km) (Des Lauriers 2006; Shackley 1999, 2002, 2004a, 2004b; Shackley et al. 1996). Obsidian from Isla Ángel de la Guarda has been documented at Laguna Manuela (120 km) (Shackley 2004a). Puerto El Parral obsidian has been found as far away as Laguna Manuela (250 km) (Shackley 2004a). Obsidian coming from San Felipe appears at Bahía de los Ángeles (250 km) and also within California, in western San Diego County (Laylander 2005; Shackley 1995).

Distances of these magnitudes are impressive, but they are not exceptional, to judge from obsidian studies in California. In the latter region, for instance, Coso obsidian occurs regularly if sparsely on that state’s central and southern coasts, 270-380 km from its source (Hughes and True 1985). Recently, an obsidian biface recovered at an Orange County site was matched to a geological source in northeastern California, more than 1,000 km from where it was ultimately

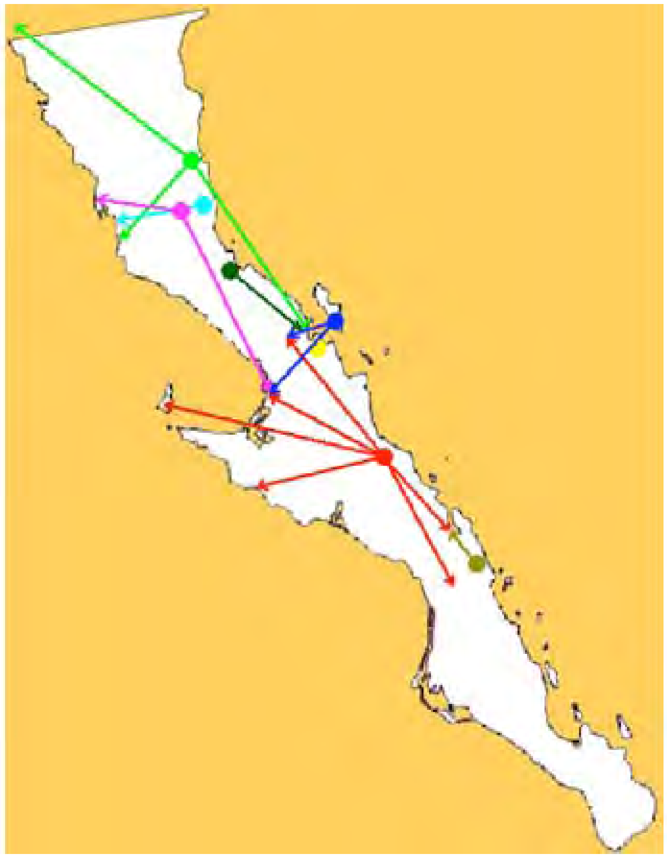

Figure 3. Ranges of archaeological obsidian from known sources.

discarded (Macko et al. 2005).

How was the material moved across such distances as these? On the basis of general ethnographic analogies, it seems improbable that locations separated by distances on the order of 100 km or more lay within the annual foraging ranges of individual prehistoric communities, unless the prehistoric population densities were exceptionally low or the territoriality of communities was exceptionally weak (cf. Kelly 1995:112-115). Neither of those latter conditions seems to have prevailed in Baja California, at least during the latest period of prehistory as it is revealed in the ethnohistoric record. Consequently, it is probably reasonable to interpret at least the longer of the ranges for Baja California obsidian as strong evidence for intercommunity exchange systems. In order to determine the mechanisms that moved obsidian over shorter distances, whether through intercommunity exchange or through direct procurement, intensive studies will need to look more closely at how the material was worked, how it was used, and how it is distributed archaeologically.

It is also interesting to note where obsidian did not go, or at least where it rarely went. Evidence for any prehistoric use of obsidian at archaeological sites in the Cape Region seems to be lacking at present, based on some fairly substantial published data. For example, studies at the site of El Conchalito in La Paz recovered 1,081 lithic items, none of which were made from obsidian (Rosales-López and Fujita 2000:94). A collection of 1,371 projectile points from sites lying between Comondú and the Cape included only one obsidian point, and that specimen came from San Javier, near the northern limit of the collection (Carmean 1994). In contrast, obsidian was apparently used fairly commonly in the Comondú area (Tuohy 1978:74).

This failure to trade obsidian farther south does not appear to represent a case in which an equal or superior local tool stone out-competed the potentially imported material. The Cape Region lithics are mostly crystalline volcanic rocks, such as basalt and rhyolite, and do not appear to have been made from particularly high-quality material. To reach various parts of the Cape Region, it would have been necessary to carry obsidian across about 420-550 km from Valle de Azufre, or 250-380 km from Punta Mangles. Those distances are substantial, but they are not out of keeping with those that were spanned by obsidian specimens in California. The absence or scarcity of obsidian in Cape Region deposits may offer some archaeological support for the old idea that the Cape Region was prehistorically isolated from the outside world to an unusual degree (e.g., González-José et al. 2003; Massey 1961; Rivet 1909). It will be interesting to learn more about the frequency of obsidian in archaeological sites lying between Comondú and La Paz, when more extensive archaeological information becomes available from that region.

Another archaeological pattern that has been suggested is that obsidian moved more widely from its sources along east-west axes than along north-south axes within the peninsula (Ritter 2001). This generalization has now been undermined by the identification of single pieces of Valle de Azufre, Puerto El Parral, and San Felipe glass in sites far to the north or south of their geological sources. However, it remains true that the area within which Valle de Azufre obsidian was the predominant glass extended farther to the west (to the Vizcaíno lagoons and Isla Cedros) than it did to the north, where Isla Ángel de la Guarda and Unknown A obsidian predominated around Bahía de los Ángeles and San Borja. To explain this pattern, it has been hypothesized that north-south discontinuities in the distribution of obsidian from particular sources may mark the geographical boundaries between prehistoric ethnic territories, more or less matching the ethnohistorically documented linguistic territories (Hyland 1997, 2006).

Such an interpretation appears to be premature, at best (Figure 4). One problem concerns the location and character of the linguistic boundaries, about which there is no firm consensus (Laylander 1997; Massey 1949; Mixco 1978, 1979, 2006). Valle de Azufre is located within the territory of what may have been the Ignacieño dialect of the Northern Cochimí language. To the north lay the territory of the Borjeño dialect, and Valle de Azufre obsidian has been found in only meager amounts around San Borja, although it is more common at Laguna Manuela, which may have been within Borjeño territory. To the south, across what appears to have been a more fundamental linguistic boundary, Valle de Azufre obsidian is the predominant glass found at Bahía de la Concepción, where the Cadegomeño dialect of the Southern Cochimí language was spoken.

All of the known sources of obsidian in Baja California are located on or near the peninsula’s eastern coast. If obsidian sources were used according to a simple least-distance principal, the ranges of particular sources would be expected to have extended farther to the west, where there were no competing sources, as contrasted with the north or south. More extensive future studies may be able to document true anomalies in obsidian distribution patterns that are attributable to social or cultural divisions. For now, it seems tenable to propose that the predominant obsidian used at any site was the closest good-quality glass, which may have been acquired either through direct procurement or by intercommunity exchange, but without regard to any serious social or cultural barriers.

Another pattern worth considering for its possible interpretive significance is the co-occurrence of obsidian coming from multiple sources at some archaeological sites. At present, the best evidence for this is seen at sites around Bahía de los Ángeles, San Borja, and Laguna

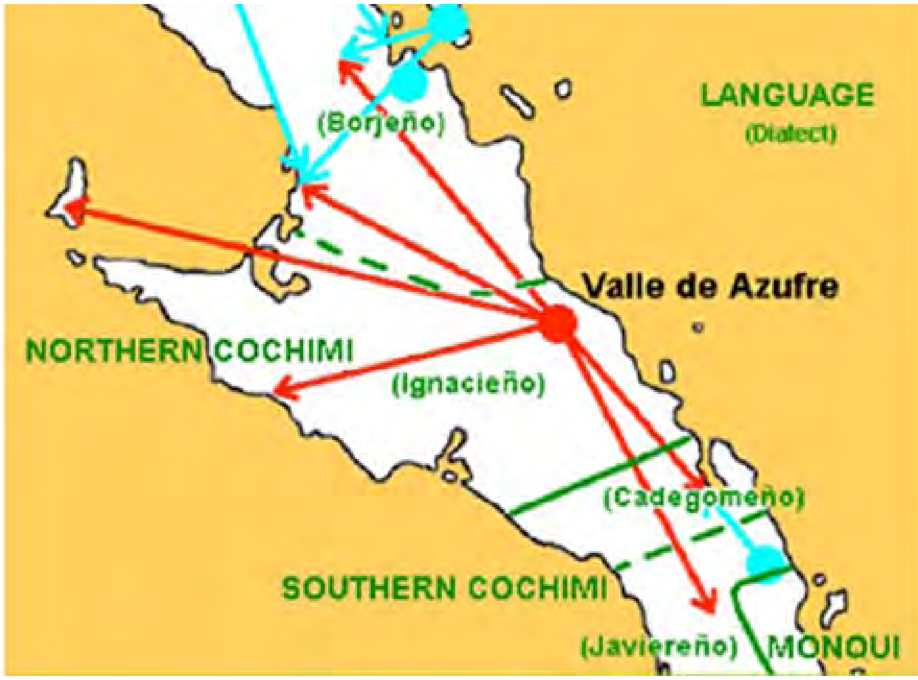

Figure 4. Range of Valle de Azufre obsidian and estimated linguistic boundaries.

Manuela (Table 1). Several possible explanations for the presence of multiple-source obsidian might be suggested. One is that it reflects differences in the quality of the obsidian that was available from the different sources. For example, a more local but lower-quality obsidian might have been used alongside a higher-quality but more expensive imported glass. Another possibility is that types of obsidian with different properties, particularly types that occur in larger or smaller nodules, might have been used for different purposes by the same people. A third explanation is that different obsidian sources may have been variously available or inaccessible to a site's inhabitants during different periods of prehistory.

An alternative explanation that may be worth exploring is that the use of material from multiple sources reveals something about the operation of prehistoric social systems. Obsidian may not have been a mere commodity, exchanged on the basis of its practical economic value. It may also have served to express and facilitate other kinds of interactions between different communities, in such matters as joint participation in ceremonies, intermarriage, and military alliances, as well as contributing to the exchange of economically more important resources or products.

Obsidian hydration studies

This second category of obsidian studies is less well developed in Baja California than sourcing studies. However, substantial numbers of hydration measurements are gradually being accumulated. The information collected for this review includes 339 readings (Figure 5). A few preliminary attempts have been made to calibrate these measurements to calendrical ages (Laylander 1987:435-436; Meighan 1978:9; Ritter 1979:120) (Figure 6), but there is no consensus among researchers as to proper approaches to the problem of calibration.

A basic issue concerns whether hydration measurements ought to be used merely as indicators of relative age, expressed as so many microns of hydration, or whether they should be

Table 1. Occurrence of obsidian from multiple sources at selected Baja California sites.

Region	Site	San Felipe	Puerto El Parral	Arroyo Matomí	Isla Ángel de la Guarda	Valle de Azufre	unknown
San Quintín-El Rosario	PASE-151	--	9	1	--	--	--
San Borja	San Ignacito	--	--	--	1	2	1
	UCBS-53	--	--	--	4	--	1
Bahía de los Ángeles	Aguaje de San Juan	1	--	--	28	--	19
	UCBC-19	--	--	--	3	--	1
	UCBC-46	--	--	--	3	--	1
	UCBC-47	--	--	--	3	--	1
Vizcaíno lagoons	LM-2	--	--	--	--	6	1
	LM-5	--	--	--	--	3	1
	LM-6	--	--	--	--	4	1
	LM-8	--	--	--	--	1	1
	LM-9	--	--	--	--	1	1
	LM-18	--	1	--	--	3	--
	LGN-3	--	--	--	--	1	1
Sierra de San Francisco	Los Corralitos	--	--	--	--	80	1

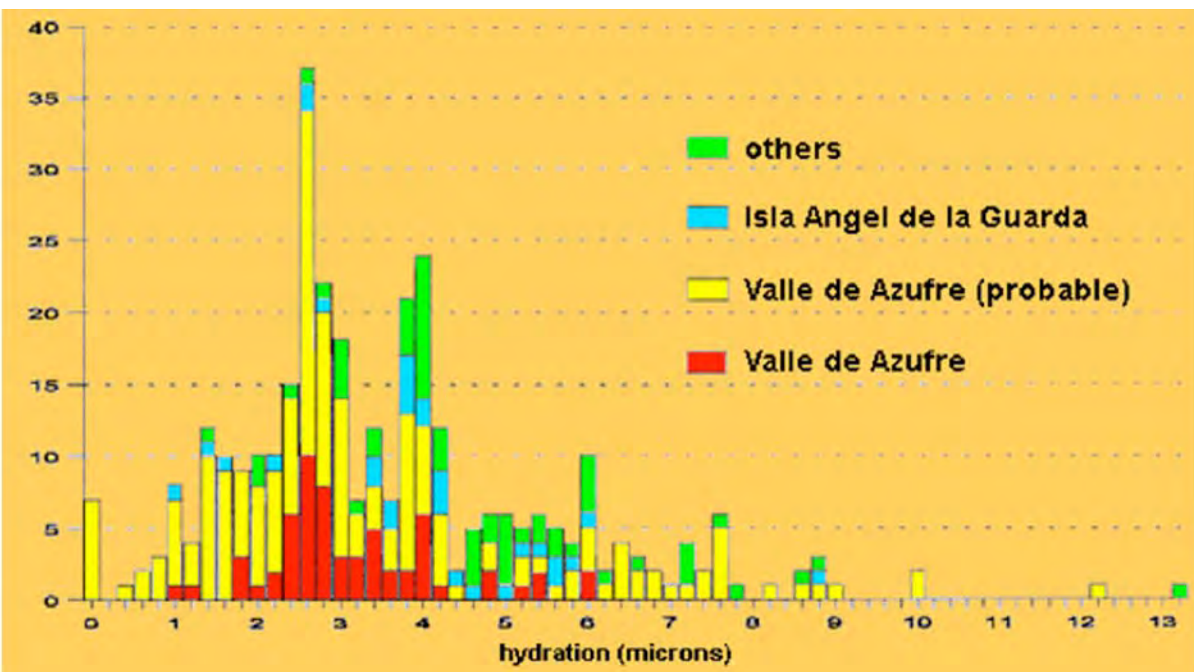

Figure 5. Frequencies of obsidian hydration readings.

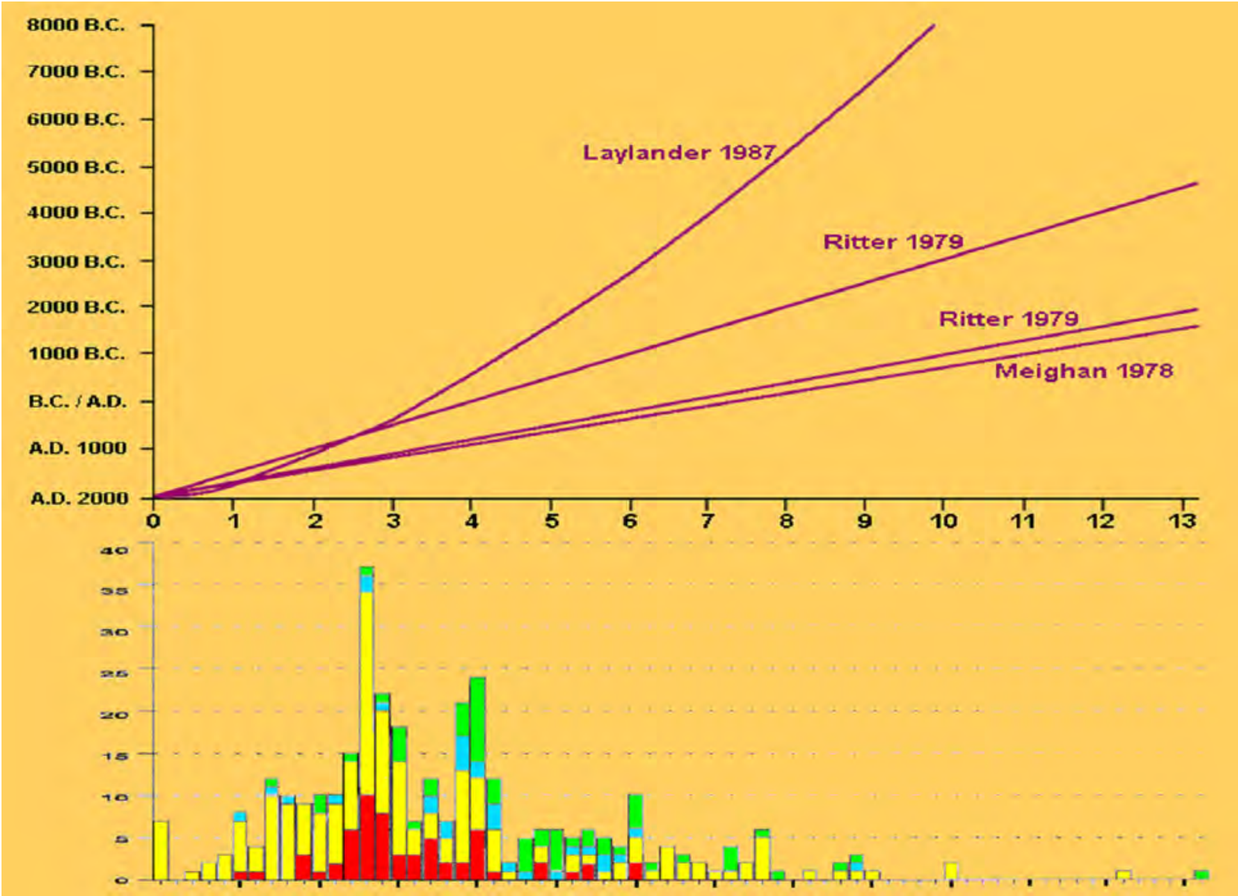

Figure 6. Proposed obsidian hydration calibration rates.

converted into estimates of absolute age, in years. If the latter, what mathematical form should the conversion take? Whether they are interpreted as relative or as absolute ages, a key issue concerns how much accuracy and precision should be attributed to hydration ages. A detailed inquiry into these issues would go beyond the scope of the present discussion. However, some personal judgments may be offered for consideration:

(1) Treating hydration chronologies as absolute rather than relative seems likely to be the more productive approach. Regionally, a framework of absolute chronology for Baja California prehistory exists, based on other chronometric methods, in particular radiocarbon dating. Hydration chronologies can be linked into that framework, directly or indirectly. One of the most important advantages of treating hydration measurements as absolute rather than relative age estimates is that this makes the interpretations more vulnerable to being contradicted by other, independent sources of chronological information. Testing calibrations is the way to refine the chronology and to develop realistic estimates of the accuracy and precision that have been achieved.

(2) For calibration, the greatest promise seems to be offered by exponential formulas, such as $y = a\ h^{b}$, in which y is number of years elapsed between the knapper's exposure of the surface and the archaeologist's measurement of its hydration; h is the thickness of the hydration rim, in microns; and a and b are empirical constants, with b greater than 1. Linear calibrations ($y = a\ h$; that is, $b = 1$) were previously favored, but these seem to be inherently unable to accommodate both the early exploitation of obsidian within the region and its continued use

down to late prehispanic times, given the limited range of the observed hydration values.

(3) Viable calibrations are most likely to be developed by taking advantage of a combination of independent parameters, including associations between readings and radiocarbon dates, readings on chronologically diagnostic artifact types (particularly projectile points) and the timing of initial settlement within the region and the historic-period abandonment of obsidian use. It is possible that changes through time in lithic technology may also prove to be useful indices.

(4) Experience in other regions indicates that calibrations will need to take into consideration the differences between the glass coming from different geological sources and the effects on hydration rate from different postdepositional temperature regimes.

(5) It is important not to hold unrealistic expectations about the accuracy or precision that will be available from emerging hydration chronologies. At best, hydration dates will probably have to be understood as time ranges covering several centuries, or perhaps as much as a millennium (cf. Laylander 2002). Even on this broad time scale, a certain proportion of anomalous readings should be expected. Calibration proposals should be regarded as provisional and subject to ongoing refinement.

A useful byproduct of hydration studies, which have been directed primarily toward chronology-building, has been the information hydration also provides about prehistoric practices in the scavenging of tool stone. Scavenging is attested by hydration bands with two or more significantly different thicknesses on a single artifact. A study of hydration readings in California (Waechter and Origer 1993) found that regions differed in the percentages of multiple-band specimens: northeast/north-central California, 1.2%; north coast ranges, 8.9%; San Francisco Bay/delta, 1.6%; south-central Sierra Nevada, 2.1%; eastern Sierra, 8.0%; desert, 2.7%; and south coast, 3.7%. Another study confirmed a multiple-band frequency of 3.3% for the San Diego area (McFarland 2000).

In the sample of Baja California hydration readings that was assembled for this paper, 7.7% (24 out of 310 specimens) had multiple bands, indicating a relatively high level of obsidian scavenging. For regions within the peninsula that have produced substantial obsidian hydration samples, results indicate high frequencies of multiple-band specimens around San Borja (11.9%, n = 42), the Vizcaíno lagoons (8.6%, n = 93), and San Ignacio and the Sierra de San Francisco (13.7%, n = 51). Low frequencies were found around Bahía de los Ángeles (2.9%, n = 34) and Bahía Concepción (2.3%, n = 87). These statistics are still based on very small samples. It is not yet clear what the regional contrasts in scavenging frequency mean, in terms of prehistoric behavior.

Prospects

Obsidian studies can be expected to make substantial contributions to the understanding of Baja California's prehistory. This will occur as more regions within the peninsula receive intensive archaeological investigations, as more sourcing and hydration data accumulate, and as more attention is focused on their interpretation.

One of the keys to promoting this process is to find better ways to share data and ideas among researchers from several countries. By themselves, a few hydration readings or chemical characterizations may not tell a great deal, but when they are added to a collective pool of research results, and when that pool is made available to all researchers, interesting patterns are likely to emerge. Some of the initiatives to promote such sharing of data and ideas in Baja

California archaeology have included INAH's annual Balances y Perspectivas conferences; ongoing publication programs, such as that of the *Pacific Coast Archaeological Society Quarterly;* and the bajacalifology web page, where the data discussed in this paper have been posted. It is to be hoped that researchers will continue to pursue obsidian studies, share their data, and engage in a vigorous but constructive debate about their interpretation.

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