ANALYSIS OF AN OBSIDIAN BIFACE FRAGMENT FROM A HOPEWELL OCCUPATION ASSOCIATED WITH THE FORT HILL (33HI1) HILLTOP ENCLOSURE IN SOUTHERN OHIO

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Ohio Historical Society archaeologists recovered an obsidian biface fragment from an occupation site associated with Fort Hill in southern Ohio. Chemical analyses of this biface indicate that it was quarried form Obsidian Cliff, Yellowstone National Park, Wyoming and chipped into its final form at around A.D. 243. This discovery adds to our understanding of the relationship between objects crafted from exotic raw materials and the Hopewellian hilltop enclosures.

INTRODUCTION

Fort Hill (33HI1) is a large, Middle Woodland hilltop enclosure located on a prominent bluff in southern Ohio (Squier and Davis 1848: Plate V). It consists of an earthen and stone wall approximately 2.4 kilometers long with an interior ditch. The wall varies in height from 1.8 to 4.6 meters.

Archaeological investigations at this site have been limited to documenting the form of the earthwork (Locke 1838; Squier and Davis 1848), describing surface collections of artifacts in the vicinity (Overman 1887; Morgan and Thomas 1948:32), conducting excavations at a Hopewell village site associated with two circular earthworks located approximately 1.6 kilometers south of the summit of Fort Hill (Baby 1954:86), and the excavation of a small trench through the wall of the hilltop enclosure (Prufer 1997). The assemblage of artifacts collected from Baby's excavations at the William Reynolds enclosure (33HI9) and the associated occupation area include a number of diagnostic Hopewell artifacts (Baby 1954; Prufer 1968, 1997). One of the most interesting items in the collection is a fragment of an obsidian biface found in the fill of a postmold (Figure 1). Griffin referred to the obsidian biface as the first find of obsidian that may have had a connection with the occupation of the so-called hill forts of southern Ohio (1965:119), although subsequent discoveries at Fort Ancient (Blosser and Glotzhober 1995:8; Essenpreis and Moseley 1984:26) have made this find less of an anomaly.

Evans and Meggers (1960) described an early attempt to provide an obsidian hydration date for the specimen. They reported a hydration rim of 5.7 microns and calculated a date of 7200 years B.P. They noted that this age estimate was older than expected (1960: Table 1, pp. 518-519).

The purpose of this paper is to present a new obsidian hydration date calculated for the Fort Hill obsidian biface fragment, one that is more consistent with the inferred cultural affiliation. In addition, we report the results of an X-ray fluorescence analysis of the specimen from which we infer that it was quarried from Obsidian Cliff in northwestern Wyoming (Skinner and Davis 1996).

CONTEXT OF DISCOVERY

According to the field notes of William Sassaman, the field director of the Ohio Historical Society excavations at the Hopewell occupation below Fort Hill, Robert Goslin uncovered the obsidian biface fragment while cleaning out a post hole in Square 25R-230 (Sassaman 1954:30). This postmold was a part

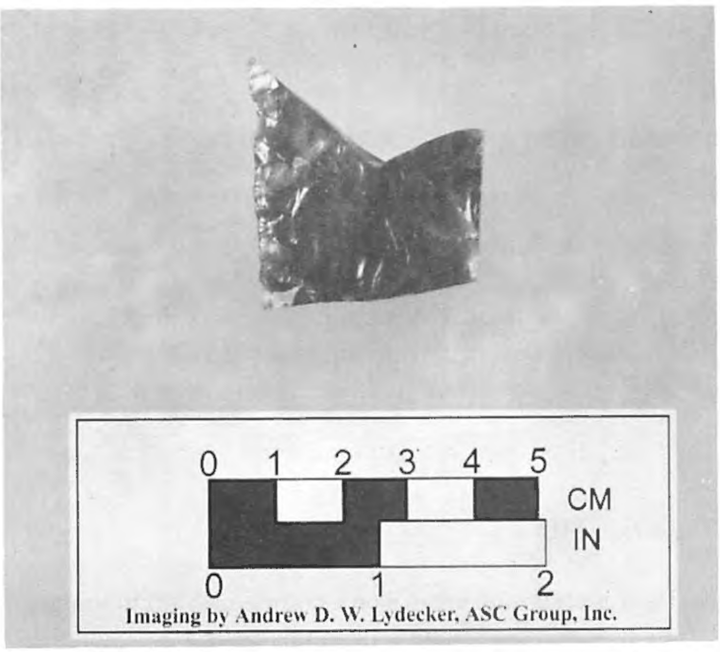

Figure 1. Photograph of obsidian biface from occupation site below Fort Hill.

of a postmold pattern that defined a large, 37 by 18 meter, sub-rectangular structure. Baby (1954: 86-87) initially interpreted the structure as a stockade enclosing a specialized craft area, although he later directed the construction of a model for the Fort Hill museum presenting the structure as a roofed building.

The excavation notes further indicate that several small pieces of mica and a quartz chip were found in association with the fragment of the obsidian blade (Sassaman 1954:30). There is no reference in the field notes to several obsidian chips later mentioned by Baby in correspondence to Griffin (1965:119); nor is any obsidian debitage curated in the Ohio Historical Society's collections from this site. This confusion is unfortunate because the implications of the specimen could be quite different if it was found associated with obsidian debitage or not. If it was found with debitage, then it might simply represent a production failure casually discarded after breakage. If no debitage was found in association, then it might have been a finished tool that broke in use and was subsequently deposited in the posthole after a more or less prolonged period of curation. Of course, the debitage also might have been collected for ritual disposal as at Mound 11 at the Hopewell site (Shetrone 1926:39-43) so these alternative interpretations are not mutually exclusive.

The biface fragment is curated as specimen number OHS 2189/212. It is the mid-section of a small biface, 7.3 mm thick and, originally, about 45.0 mm wide. Approximately 10.0 mm of one lateral margin has been removed, presumably in the previous effort to obtain an obsidian hydration date.

THE AGE OF THE OBSIDIAN BIFACE

Methods

The rate of molecular water diffusion into the obsidian surface is controlled by a number of factors including the glass intrinsic water content (OH), soil temperature, and soil relative humidity. Each of these parameters were estimated using the procedures developed by Stevenson et al. (1989, 1996). The high temperature rate constants were obtained through a measurement of the intrinsic water content. These were determined from glass density values using the Archimedes method. A heavy liquid (Unigrav) was used as the displacement media in order to prevent the adhesion of water bubbles to the glass surface and polished quartz with a density of 2.6488 g/ml was used as a standard. This resulted in a density value of 2.338 g/ml and an estimated OH concentration of 0.48%. The high temperature experimental hydration rate constants were estimated from the OH concentration: a pre-exponential value of A=3.73 um^2/day at 160° C and an activation energy of E=79475 J/mol. Using the Arrhenius equation, the high temperature rate or pre-exponential can be extrapolated to ambient site conditions with the activation energy constant.

the salt type monitors developed by Trembour et al. (1988). Temperature and relative humidity cells were buried in pairs at depths of 10, 20 and 30 cm below a grass-covered ground surface in a fallow agricultural field. At the end of one year the cells were recovered and returned to the laboratory for processing. This resulted in the following effective hydration temperatures and relative humidities for each depth: 10 cm: 15.1°C, 99%; 20 cm: 15.3°C, 99%; 30 cm:14.9°C, 99%. Measurements of soil relative humidity at these depths in other environments (Friedman et al. 1994) has shown that temperature decreases with depth and that near saturation or saturation is usually reached at shallow levels (10 cm).

Results

Since the artifact was recovered at a depth of 35 cm, the values for the cells buried at 30 cm below surface were used. These data do not take into account paleoclimatic change for the last 2,000 years which may have led to significant warming or cooling of the region, nor does it compensate for microclimatic differences generated by topography or vegetation. With these caveats in mind, a hydration rate of 19.76 um^2/1000 years was calculated and resulted in an age estimate for the 5.7 micron hydration rim (Evans and Meggers 1960:518) of A.D. 306±58.

THE SOURCE OF THE OBSIDIAN

Methods

Nondestructive trace element analysis of the obsidian biface was completed using a Spectrace 5000 energy dispersive X-ray fluorescence spectrometer. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9 keV X-rays (at 1,000 counts per second) in an area $30mm^2$. The X-ray tube employed is a Bremsstrahlung type with a rhodium target and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 4 to 50 kV. Specific analytical conditions used for the analysis of all elements reported here are described in Skinner and Davis (1996).

The trace element values used to characterize the sample were compared directly to published values reported for known Hopewell artifact obsidian sources (Davis et al. 1995; Hughes and Nelson 1987) and with unpublished trace element data collected by Northwest Research through analysis of geologic source samples. Artifacts are correlated to a parent obsidian source or chemical source group if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Diagnostic trace elements, as the term is used here, refer to trace elements that are measured by X-ray fluorescence analysis with high precision and which show low intrasource variation and uncertainty along with distinguishable intersource variability.

Results

The trace element values for the Fort Hill obsidian biface correspond very well with those of Obsidian Cliff, Yellowstone National Park, Wyoming (Table 1 and Figure 2). The spectacular Obsidian Cliff source was one of the first obsidian sources to be described in modern scientific literature (Holmes 1879; Iddings 1888). Artifacts from archaeological sites in Idaho, Illinois, Iowa, Michigan, Montana, North Dakota, Oklahoma, Ohio, South Dakota, Washington, Wisconsin, Wyoming, and central Canada have yielded artifacts correlated with this Yellowstone source (Anderson et al. 1986; Baugh and Nelson 1988; Davis et al. 1995; Griffin et al. 1969; Hatch 1990; Skinner 1995; Vehik and Baugh 1994; Wright et al. 1969). The geology, geochemistry, and prehistoric use of obsidian from Obsidian Cliff are most comprehensively summarized and described by Davis et al. (1995).

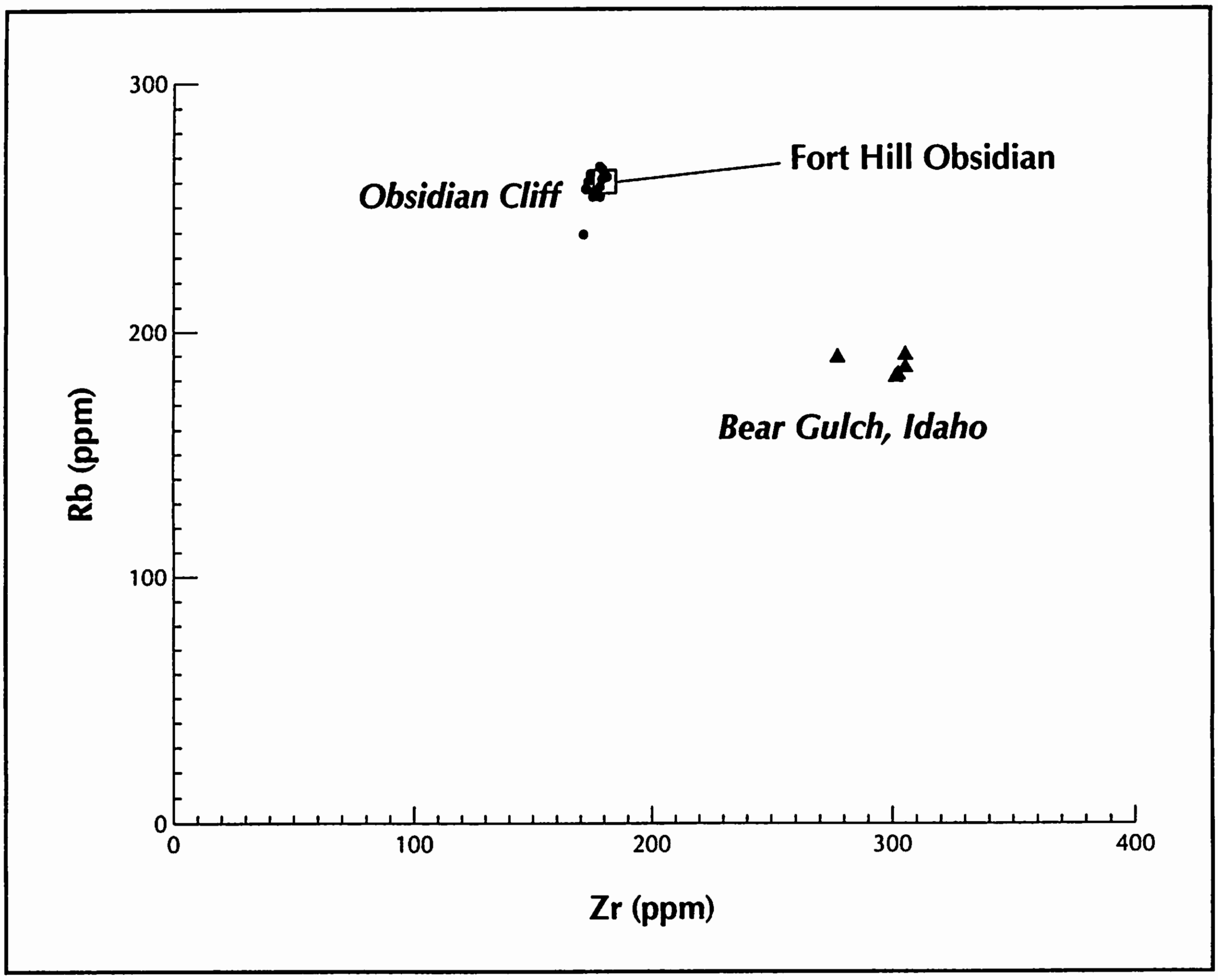

Figure 2. Scatterplot of rubidium (Rb) plotted versus zirconium (Zr) for the Fort Hill artifact and major Hopewell obsidian sources.

Element	Content (ppm)	Uncertainty (±)
Zn	78	7
Rb	260	4
Sr	4	9
Y	81	3
Zr	181	8
Nb	47	2
Ti	440	95
Mn	190	47
Fe_2O_3	1.27	0.11
Fe:Mn	76.9	
Fe:Ti	91.8	

Table 1. Trace element composition of the Fort Hill biface. All elements except iron are reported in parts per million (ppm). Iron content is reported as weight percent oxide.

The obsidian sources of Yellowstone National Park, Wyoming, were long thought to have provided the obsidian found in Hopewell sites (Griffin 1965). Trace element studies of Hopewell obsidian artifacts eventually confirmed Obsidian Cliff in Yellowstone National Park as the major primary source of most Hopewell obsidian artifacts (Griffin et al. 1969; Davis et al. 1995). A second major source of Hopewell obsidian, the Bear Gulch source, was originally thought to have also been located in Yellowstone National Park but was later identified in the Camas-Dry Creek area of eastern Idaho (Hughes and Nelson 1987; Wright et al. 1990).

CONCLUSIONS

The presence of obsidian at the Hopewell occupation site associated with the William Reynolds enclosure (33HI9) south of Fort Hill (33HI1) is significant (Griffin 1965:119). It widens the range in which the Hopewell circulated this most exotic of all the components of the Hopewell Interaction Sphere (Struever and Houart 1972), although the discovery of the Powell cache at Fort Ancient demonstrated more spectacularly that obsidian could figure prominently in the ceremonialism associated with the hilltop enclosures of southern Ohio (Essenpreis and Moseley 1984:26).

The age of A.D. 306 determined for the Fort Hill obsidian biface is somewhat younger than the ages reported for other Hopewell obsidian artifacts. Hatch et al. (1990) listed a variety of obsidian hydration dates ranging from 78 B.C. to A.D. 106 for artifacts from Mound 25 at the Hopewell site and from A.D. 150 to 308 for material from Mound 11 (Hatch et al. 1990:476). Hatch et al. (1990:478) concluded that the Hopewell obtained their obsidian "... over a span of time covering the major episode of Hopewellian mound construction in the Midwest - from the first century B.C. into the fourth century A.D."

Hughes (1992) disputed this conclusion and argued that most obsidian hydration dates from Hopewell sites are statistically equivalent at two standard deviations (cf., Stevenson et al. 1992). The relatively late date reported here for the Fort Hill specimen supports Prufer's contention, based upon an analysis of the ceramics, that the Hopewell occupation at Fort Hill occurred late in the Hopewell sequence (Prufer 1968:148).

The source of the obsidian used in the manufacture of the Fort Hill biface is Obsidian Cliff, confirming the relatively limited source area for Hopewell obsidian (Griffin et al. 1969; Hughes 1995). It is noteworthy that the obsidian from the Powell cache, discovered in association with the Fort Ancient hilltop enclosure, also was identified as Obsidian Cliff (Connolly and Sullivan 1997).

Finally, the relationship of the Fort Hill biface to the construction and use of the Fort Hill enclosure is unresolved. The spatial association of the large, subrectangular structure with the William Reynolds enclosure (33HI9), as well as with the complementary S. Rhoads circular enclosure (33HI10), suggests that the landform at the southern foot of the Fort Hill bluff was a locus of intensive ritual and, perhaps, residential activity (Lepper 1997). The immediate proximity of this area to the Fort Hill enclosure suggests a close relationship between the activities conducted at these topographically disparate locations.

Further analysis of the artifacts and notes from Baby's 1952-54 excavations, as well as additional excavations at these localities, offers the potential of refining our understanding of the Hopewellian use of the landscape surrounding their large ceremonial centers.

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