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A quarterly journal of reports and activities of mutual interest to the individuals and organizations within the framework of the Institute of Archeology and Anthropology at the University of South Carolina and for the information of friends and associates of the Institute.

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# NOTEBOOK

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The University of South Carolina offers equal opportunity in its employment admissions, and educational activities, in accordance with Title IX, Section 504 of the Rehabilitation Act of 1973 and other civil rights laws.
A METHOD FOR INFERRING VESSEL MORPHOLOGY FROM SHERD CURVATURES

Marion Smith
This is a progress report on the early stages of research on some of the ways in which ceramic artifacts functioned in past cultural systems. Underlying assumptions are that the practical functions of ceramics are important in at least some past cultural systems, that functions are reflected in size and shape of vessels, and that archeological potsherds contain data on vessel size and shape. The work described has been assisted by mathematical advice from Dr. John Dickerson of the Civil Engineering Department, University of South Carolina.

No archeologist with interests in the prehistoric Southeast or any other world areas needs to work very hard to justify some concern with ceramic material culture. Its ubiquity and its importance to classic archeological interpretations are obvious. Prominent in the commonly used classificatory schemes are stylistic or non-functional traits, which, experience has shown, are effective markers of space and time and, perhaps, cultural or ethnic affiliation.

The comparative under-development of functional studies of ceramics reflects the difficulty of studying whole vessels archeologically much more than it does a lack of theoretical potential for such studies. According to Binford (1972: 208):

the study of primary functional variation is essential to the understanding of the sociocultural systems represented by the artifacts, in this case ceramics. The nature and number of occurrences of functionally differentiated container types can yield valuable information about the size of social segments performing different tasks.

That vessel size and shape reflect the intended uses of ceramics has been empirically demonstrated. For example, Braun (1976, 1980) has shown that the frequency of desired access to vessel contents and the containment security needed can be used to predict pot uses from form and size in the historic Southwest. He has measured access needs from orifice diameter and security needs by the degree of constriction at the neck. In the same area, Turner and Lofgren (1966) have used the volume ratios of serving vessels to cooking vessels to estimate Anasazi household size through time. Their results largely parallel estimates from independent archeological evidence. Thus, strong form-function relationships seem to characterize the Southwest and possibly other areas as well. Ericson and various others (Ericson, Read, and Burke 1972; Ericson and De Atley 1976) have suggested that certain relationships of function with technology and form may be universal.

Rigorous studies of morphology need a conception of vessels which lends itself to precise, quantitative description. There is such a mathematical model which is appropriate, literally, to the degree that pots are round. Both pots and potsherds may be described in this framework. Pots may be thought of as \textit{surfaces of revolution}. Figure 1 shows the first step in abstracting the morphology of a pot. We have a vessel drawn with the familiar $x$ axis of algebra running down its cen
FIGURE 1: Vessel represented as a surface of revolution.

FIGURE 2: Vessel cross-section defining the radius $r(x_o)$. 
tral axis, and the \( r \) (radius) axis running perpendicular to the \( x \) axis. Figure 2 is a cross-section of the same vessel sliced to include both the \( x \) and \( r \) axes. The distance \( x_o \) is measured to a particular point from the pot base along the \( x \) axis, and \( r_o \) is the distance of the point from the \( x \) axis. We can abstract pot size and shape by neglecting the wall thickness of real pots, concentrating on the inner surface. Also, we can dispense with the lower half of the cross-section. If the pot is round, then the lower profile will be a reflection of the upper. With these assumptions, a round pot can be represented as the track left behind when we revolve the curve shown by 360° around the \( x \) axis (Fig. 3). This is what is meant by a surface of revolution. In mathematical terms, a curve represents the upper profile of any round pot. From the curve alone, we can calculate all quantities related to the real pot's size and shape—surface area, orifice diameter, volume, and so forth. In this study, the curves are approximated by polynomials (sums of powers of \( x \)) because they are easy to work with and can be used to represent any reasonable profile with any required accuracy. Thus a specific pot is described by writing five numerical coefficients, the \( a \)'s in the equation (Fig. 3).

Potsherds are abstractly described as points on a profile curve. Certain mathematical properties of the curve at a point summarize part of the size and shape data that relate to the whole pot. These properties are the pot radius at the point, the slope at the point, and the curvature at the point along the direction of the \( x \) axis, \( r \). Figure 4 shows the slope, which is defined as the slope of the line tangent to the curve. Figure 5 shows how curvature is defined; technically, the curvature is the reciprocal of the radius of the circle of curvature. The basic morphological variables—radius, slope, and curvature—can be determined from the profile polynomial and from what are called mathematically its first and second derivatives. For actual sherds, these variables can be estimated from measurements of surface curvature.

The experimental phase of the current research is designed to answer the question, "How—and how well—can we determine the basic morphological variables of radius, slope, and curvature from sherds of the sort which archaeologists might hope to recover?" Initial answers to this question have been encouraging. Several rather crude hand-coiled modern vessels have been broken into fragments from about crouston size to about 10 centimeters diameter. It turns out that one can usually determine with good accuracy the vertical (parallel to \( x \) axis) and horizontal (parallel to rim) directions of the original pot. This is done by taking the radius of curvature measurements with a molding gauge, in a "polar pattern" (Fig. 6). The maximum radius of curvature measurement and the minimum measurement roughly indicate—but do not distinguish between—the vertical and horizontal directions. Vertical is distinguished from horizontal by considering that inner surface curvature along a horizontal line will be concave and constant. Figure 7 shows the "cross pattern" of measurement taken after the perpendicular vertical and horizontal directions are known. If, for example, it is determined that \( R_{10} \), \( R_r \), and \( R_6 \) are equal, Axis 2 must be horizontal and Axis 1 must be vertical. Figure 8 summarizes the experimental estimation of pot directions for body sherds. The estimated direction and the actual direction are plotted for 11 sherds from three experi
FIGURE 3: Representation of a vessel profile as a polynomial curve.

$$r(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5$$

FIGURE 4: Definition of the slope of the vessel wall.

Slope = \( \frac{\Delta r}{\Delta x} \)
FIGURE 5: Definition of the radius of curvature of the vessel wall.

FIGURE 6: Curvature measurements to determine the orientation of the vessel: the "polar pattern."
mental vessels. The correlation coefficient is 0.83, which should occur by chance scarcely one time in a thousand.

FIGURE 7: Curvature measurements to estimate the pot radius, slope and curvature: the "cross pattern."

Algebraic expressions for the basic variables in terms of the radius measures are below:

- **Slope**
  
  \[ \text{Slope} = \frac{(R_3 - R_4) R_2}{2d (R_2 + R_1)} \]  
  
  (d is the distance between the measurements)

- **Vessel radius**
  
  \[ \text{Vessel radius} = \frac{R_1}{(1 + \text{slope}^2)^{1/2}} \]

- **Vertical curvature**
  
  \[ \text{Vertical curvature} = \frac{(1 + \text{slope}^2)^{3/2}}{R_2} \]

Geometric properties of a surface of revolution lead to these relationships, but their derivation cannot be given in detail here. The formulas show that slope plays a critical role in defining radius and curvature. Figure 9 shows slope estimates from sherd measurements compared to actual slope values. Problems with the technique for measuring curvature and irregularities of the hand-built pots are probably
FIGURE 8: Estimation of pot orientation from polar pattern measurements.

FIGURE 9: Estimation of pot slope from cross pattern measurements.
responsible for the disappointing results. Because of the large slope error, radius and vertical curvature estimates were not attempted. Figure 10 illustrates why I am nevertheless optimistic about the ultimate outcome of vessel reconstruction from sherd curvatures: it compares a different, and cruder, estimate of pot radius with actual radius measurements. There appears to be a fairly strong linear relationship between prediction and reality. Thus fairly good radius determinations may be possible even without slope estimations.

Reconstructing vessels from sherds has two aspects. Aspect One is to describe the morphologies of all the pots contributing to an assemblage of sherds, from the sherds. Necessarily, the description will have to be a generalized and statistical one. This would have very wide applications, since the required data base would consist only of a few dozen sherds of at least 4-5 centimeters diameter. Aspect Two is to reconstruct particular vessels using three or four sherds which can be identified as from the same vessel. This is a more glamorous project because one could hope for specific, tangible results; but ultimately less important than Aspect One because the recovery and identification of sherds from the same vessel is a relatively rare event. Aspect Two has been attacked with the aid of a computer program called POTS, an acronym for "Pots from Tiny Sherds."
POTS reads a description of a hypothetical pot, simulates the recovery and measurement of a specified number of sherds from the vessel, and reconstructs the original pot using only sherd measurements of radius, slope, and curvature. The current version of the POTS program operates in an unsophisticated way that makes early results all the more encouraging. Basically, POTS chooses at random mathematical curves against which to compare the sherd measurements. All the sherd measurements are compared to calculated random curve "measurements" at positions up and down the random curve. The point on the curve where radius, slope, and curvature best match the simulated sherd measurements is located. The best reconstruction of the original vessel is the random curve that fits the sherd data with the least total error.

A POTS run is illustrated with a conoidal pot and five simulated sherds (Fig. 11). The vessel appears in surface of revolution form, with rim to the right. Figure 12 shows the first random curve. The light line is the random curve; the vessel profile is superimposed as the double line. The bar-like figures indicate sherds randomly sampled from the length of the pot wall. Figures 13 through 16 show the gradual convergence of the curves toward the original shape. "Error" indicates the numerical difference between sherd measurements and best fitting curve measurements, considering all the sherds together. Figure 16 shows the best reconstruction found among the first 500 random curves. It is upside down, obviously: except at the rim and base there is no general way to distinguish up from down on a plain sherd. In most cases, including this one, the reconstruction makes sense in only one of the two possible orientations. This early study of vessel reconstruction is even more heartening, considering that archeologists should be able to take advantage of prior knowledge concerning the ceramic morphologies of their areas, and considering that more powerful versions of POTS are being planned. These will examine the potential of the application of prior knowledge and will "learn" from experience with a particular batch of sherds. It should be pointed out that computer simulation allows comparison of alternative strategies for reconstruction independent of the current success of experimental attempts to measure radius, slope and curvature on sherds.

Two major points have not been made: (1) much information on the size and shape of ceramic vessels survives in the sherds derived from them, and (2) this information may be sufficient to reconstruct the original vessels. Both theoretical considerations and empirical evidence (e.g., from the Southwest) suggest that the primary functions of vessels are major causes of morphological variation.

Future work will explore how function can be studied from the multiple-vessel sherd collections usually occurring in archeological contexts. Ceramic vessels from several ethnographically documented cultures will be grouped by functional categories. A computer program will simulate the fragmentation of these vessels into sherds. It will also "measure" the morphological variables on the assemblages derived from each use category of vessels. The statistical method of discriminant analysis will then determine how measurements of the morphological variables can be used most effectively to distinguish the known vessel functions.
FIGURE 11: Pot profile and five sherds derived from it for simulated reconstruction.

FIGURE 12: Comparison of first random curve with the pot outline. The total error in arbitrary units is 350,000.
FIGURE 13: Third random curve. Error is 69.6 arbitrary units.

FIGURE 14: Seventh random curve. Error is 4.7 arbitrary units.
FIGURE 15: Forty-eight random curve. Error is 2.3 units.

FIGURE 16: The best reconstruction of the pot: the three hundred twenty-third random curve, the best of the first 500. Error is 0.39 units. The random curve is a close approximation of the pot outline.
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A PROGRESS REPORT ON THE
SMALL-WATERCRAFT RESEARCH
PROJECT IN SOUTH CAROLINA

Ralph Wilbanks
INTRODUCTION

Since Hampton Shuping discovered the Brown's Ferry Vessel in 1974, the Division of Underwater Archeology at the Institute of Archeology and Anthropology has been conducting research concerning small watercraft utilized on more than 6,000 miles of rivers and streams within South Carolina. This small-craft project is designed to encompass prehistoric as well as historic vessels used to transport people or goods. To date, the Brown's Ferry Vessel (Albright and Steffy 1979; Steffy 1979; Singley 1981) is the most thoroughly researched watercraft in the project, but research on other vessels has been initiated. For example, an 1830's cargo vessel located in the Cooper River was described in detail by Wilbanks (1981) at the Conference on Underwater Archeology in New Orleans in January, 1981. The research on historic river-coastal trading vessels continues to generate a vast amount of information about shipbuilding in the South; however, this is only one part of the scope of the project.

Another phase of the watercraft project concerns the study of canoes, both prehistoric and historic in origin. Since this project was initiated, 23 canoes have been discovered by or reported to the Institute staff. Although absolute dating methods have not been employed, these canoes appear to range from the late prehistoric period to the early years of the twentieth century and to range in length from 12 to 30 feet. The primary wood types are cypress and pine. The historic canoes were generally constructed using an adze and an axe. In some cases, an auger, a mallet, and, in at least one case, a chisel were utilized in the construction. The canoes considered prehistoric are all similar in method of construction. They all have evidence of charring, which indicates a method similar to one first recorded by Thomas Harriot in 1588 and published by Theodor de Bry in 1590 (Fig. 1). This method consisted of felling a suitable tree, using fire, then using a controlled fire and shell tools to hollow and shape the canoe. The exact quote follows:

The manner of makinge their boates in Virginia is verye wonderfull. For wheras they want Instruments of yron, or other like vnto ours, yet they knowe howe to make them as handsomelye, to saile with whear they liste in their Riviers, and to fishe with all, as ours. First they choose some longe, and thicke tree, accordinge to the bignes of the boate which they would frame, and make a fyre on the ground abowt the Roote therof, kindlinge the same by little, and little with drie mosse of trees, and chippes of woode that the flame should not mounte opp to highe, and burne to muche of the lengte of the tree. When yt is almost burnt thorough, and readeye to fall they make a new fyre, which they suffer to burne vntill the tree fall of yt owne accord. Then burninge of the topp, and the bowghs of the tree in suche wyse that the bodie of the same may Retayne his iust lengthe, they raise yt vpon potes laid ouer cross wise vpon forke postes, at suche a
reasonable heighte as rhey may handsomlye worke vppo yt. Then take they of the barke with certayne shells; they reserue the, innermost parte of the lenkke for the nethermost parte of the boate. On the other side they make a fyre accordinge to the lengthe of the bodye of the tree, sauinge at both endes. That which they thinke is sufficientlye burned they quenche and scrape away with shells, and makinge a new fyre they burne yt agayne, and soe they continne somtymes burninge and sometymes scrapinge, untill the boate have sufficient bothowmes. This god indueth thise savage people with sufficient reason to make thinges necessarie to serue their turnes.

FIGURE 1: A 16th century illustration showing the technique of Mississippian Indian canoe construction.

For centuries prior to 1590, this type of construction appeared not to have changed. In 1972, Pittman and Lipe reported the same type of construction in a canoe recovered from the Black Lake near Elizabethtown, North Carolina. The Black Lake canoe was dated with a radio-carbon age at A.D. 1005 (Pittman et al. 1972).

Small-craft research is not a full-time aspect of the Institute's Underwater Division; it is only a phase of its broader responsibilities to manage South Carolina's underwater archeological resources. In an effort to disseminate the information already on hand, the Underwater Division will publish a series of short articles concerning canoes and
other watercraft in the Notebook. The frequency of these articles will depend on the amount of time available to work on the already assembled information and to gather new information. For example, of the 23 canoes already mentioned, some have not been inspected; some are buried and cannot be analyzed until more fieldwork has been undertaken.

Four canoes were selected for description in this initial article: (1) the Kizer-Judy Canoe, (2) the Ferguson Canoe, (3) the Cut Dam Canoe, (4) the Chessey Creek Canoe. The first three were located primarily because of excessively low-water levels in the Edisto River and the Wateree Swamp, and the fourth was reported to the Institute from an article in the Press and Standard, a Walterboro, South Carolina newspaper. All of the canoes were located in 1980, and all but the Chessey Creek Canoe were discovered underwater. Due to the conservation problems associated with waterlogged wood, these canoes were raised only for a short time for photography and measurement and were replaced underwater until proper conservation could be undertaken. The Chessey Creek Canoe was discovered on the edge of a spoil area and was probably raised over 20 years ago. This extended exposure to the atmosphere has undoubtedly caused irreparable damage; however, the canoe has reached an equilibrium with the environment, and, although it will require some conservation, this will not be as extensive or as expensive as that for the other three. In the following pages, I briefly describe the four canoes and offer some suggestions of their origin and use.

The Kizer-Judy Canoe

The Kizer-Judy Canoe was discovered in the Edisto River near Branchville, South Carolina, in September, 1980. The canoe, historic in origin, had been removed from the original site by Furman Kizer, J. V. Judy, and eight others. Two Institute Staff members visited the discoverers and photographed and measured the canoe. On a subsequent visit, the Division Staff assisted in placing the canoe in a secure underwater storage area.

The condition of the Kizer-Judy Canoe is excellent, although one end was broken off approximately 30 years ago by loggers in an aborted attempt to remove the canoe.

The canoe is finely crafted and was probably used to carry trade goods and plantation products on the Edisto River, as well as for simple transportation. This canoe was shaped using an adze, as evidenced by several tool marks. The outer hull has 3/4-inch diameter treenails (wooden pegs) spaced approximately every 3 1/2 feet. These were placed in the log before the hollowing process was completed and were used by the builder(s) to gauge depth. In this way, he achieved a uniform thickness. The canoe tapers slightly inward towards the broken end. There appears to be a very slight keel protruding downward about 1/2 inch. This would aid in the stability of the craft. The age of this canoe will be very difficult to determine because this construction method was utilized throughout the historic period. Future comparative research may one day aid in the dating of this canoe.
The remaining centerline length was 28 feet, 7 inches; the extreme beam, 2 feet, 5 inches; the interior width, 2 feet, 1 inch; hull thickness, 2 inches; and wood type, cypress.

The Ferguson Canoe

The Ferguson Canoe was discovered in the Edisto River near Cottageville, South Carolina, in September 1980. Mr. Ralph Ferguson and five others removed the canoe from the river to his home and contacted the Institute immediately. Two Staff members of the Division of Underwater Archeology met Mr. Ferguson the next day and measured and photographed the canoe. The design of the canoe and several tool marks suggested this was another historic period canoe. The canoe was replaced underwater in a secure pond.
The Ferguson Canoe is in good condition; however, there is a hole in the bottom, and a small part of the stern is missing (Fig. 3). The canoe is a flat-bottomed river and swamp boat that was probably used for transportation on hunting and fishing trips. The only clue to the age of this canoe was a square nail and several links of wrought chain located in the bow. The stern of the canoe was 10 inches thick and very rotten. Some tool marks were evident. The canoe had no keel and was a very shallow draft vessel for operating in the shallow swamps of the coastal area.

The Ferguson Canoe's remaining centerline length was 15 feet, 4 inches; the extreme beam, 2 feet, 5 inches; the interior width, 2 feet, 2 inches; hull thickness, 1 inch; and wood type, probably cypress.

The Cut Dam Canoe

In November, 1978, a portion of a prehistoric canoe was recovered from Beach Creek in the Wateree Swamp. This canoe was recovered by Bunk Cain, Jessie Singleton, and Tommy Mullis, all from Sumter, South Carolina. The canoe was inspected at Mr. Cain's home in Sumter and photographed, measured, and placed underwater in a protected pond near his home. In an effort to locate more of the Canoe, a one-day search of the discovery site in Beach Creek was undertaken in December, 1978, without success.

The condition of the canoe is poor because the wood is very rotten and waterlogged (Fig. 4). The canoe was badly broken with only one end still present. The interior and exterior surfaces were covered with charcoal, some at least one-half-inch deep. The charcoal will be submitted for a radiocarbon date. The bottom of the canoe was slightly rounded. It was impossible to estimate the original length of this canoe because too much was missing. The construction method appears to be similar to the type described by Harriot earlier in this article.

The Cut Dam Canoe's remaining centerline length was 8 feet, 6 inches; the extreme beam, 2 feet; the interior width, 1 foot, 8 inches; hull thickness, 1 foot, 7 inches; and wood type, probably pine.
FIGURE 4: (L-R) Jessie Singleton, Tommy Mullis, and Bunk Cain, the finders of the Cut Dam Canoe.

The Chessey Creek Canoe

In October, 1980, the Division staff inspected another historic canoe reported to the Institute because of a newspaper article in the Press and Standard. This canoe was located by Mr. Earl Marvin of Walterboro, South Carolina, in the swamp off Chessey Creek on property belonging to Mr. Bink Sanders.

As previously mentioned, the Chessey Creek canoe was underwater until probably 20 years ago when it was dredged up by a drag line digging a canal in the area. Since that time the wood has reached an equilibrium with the environment and therefore can be conserved in a less expensive manner. However, the exposure certainly has not been beneficial for the wood, and some of the details are surely obscured (Fig. 5).

The condition of the Chessey Creek Canoe is fair; part of one gunwale is missing, and the canoe generally has been weakened by the roots of various plants and trees growing in the dirt that has been deposited on the interior of the canoe (Fig. 5).

Several tool marks are visible on the exterior surface. These are probably adze or axe marks. The interior is full of dirt, weeds, and
decaying foliage, so the inside may yield more tool marks. The bow has a cut nail on the upper surface, probably used for securing lines. There are several notches on the midship seat and the stern. The function of the notches has not yet been determined. They may have been intended to improve comfort while sitting on the seats. This flat-bottomed, keelless canoe was very similar to the Ferguson canoe that was used for transportation on hunting and fishing trips for one or two people. The shallow draft of this canoe made it ideal for navigating the shallow swamps of the Ashepoo drainage system. The cut nail already mentioned may be the only means of dating this canoe.

The remaining centerline length was 12 feet, 11 1/2 inches; the extreme beam, 1 foot, 6 inches; the interior width, 1 foot, 2 inches; the interior depth, 9 inches; hull thickness, 2 inches; and wood type, probably cypress.

Conclusions

The large number of canoes currently known to us offers a unique opportunity to study the evolution of the type of craft most widely used in prehistoric and historical times. The four canoes described in this article differ in shape but are basically the same in function. The three historic canoes were manufactured using iron tools, probably adzes and axes. The treenails found in the Kizer-Judy Canoe illus-
trated a common practice that was utilized by builders who possessed a thorough knowledge of their trade.

When all the available material from these canoes has been analyzed, we hope to have the rudimentary beginning of a chronology of hull types. Comparative data from such a large number of canoes give us an unparalleled opportunity to study this type craft in South Carolina. We wish to thank the finders of the canoes for demonstrating their interest in the heritage of South Carolina by reporting their finds and assisting in the preservation of them for future generations. As additional information is received on the canoes discussed in this article, it will be reported in subsequent articles.
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Wilbanks, Ralph
A NOTE ON MOUNT SAINT HELENS' NINETEENTH CENTURY ERUPTIONS

Robert L. Stephenson
INTRODUCTION

Since the recent volcanic activity at Mount St. Helens, I have read a few articles concerning the eruptions of March, April, May, and June 1980, but have seen almost no mention of the volcanic history of this mountain. Occasional comments to the effect that this is the first eruption of Mount St. Helens since 1857 are about all I have seen. Perhaps the subject has been dealt with in some detail by someone, but, if so, its publication has not come to my attention. Curiosity prompted me to inquire into the matter not so much as an historical exercise but as a hint about predictability of the presently occurring volcanic episode as that predictability might reflect the previous pattern of events. Was the 1857 eruption a single event or a part of a series of events? How and by whom was the nineteenth century record made? Did the nineteenth century eruption (or eruptions) resemble the 1980 series of eruptions?

This is in no sense an exhaustive study of the nineteenth century history of this mountain. It is simply a note bringing to general attention the fact that Mount St. Helens has a complex history of eruptions throughout the first half of the nineteenth century. It is derived primarily from early issues of the Oregon Historical Quarterly, a rather remarkable journal documenting events of the Pacific Northwest since its first issue in March 1900.

The earliest record I find of Mount St. Helens is that provided by Captain George Vancouver of the British Royal Navy. While standing off the mouth of the Columbia River in H.M.S. Discovery, on Saturday, October 20, 1792, toward sunset, he named this mountain. The ship's log records: "The clearness of the atmosphere enabled us to see the high round snowy mountain, noticed when in the southern parts of Admiralty inlet, to the southward of Mount Rainier; from this station it bore by compass N. 77° E., and, like Mount Rainier, seemed covered with perpetual snow, as low down as the intervening country permitted it to be seen. This I have distinguished by the name of MOUNT ST. HELENS, in honor of his Britannic Majesty's ambassador at the court of Madrid. It is situated in latitude 46° 9' and in longitude 238° 4' according to our observations" (Elliott 1917: 240; Vancouver 1798: 421-422).

According to McArthur (1952: 528) "Vancouver named the mountain in honor of Baron Saint Helens (Alleyne Fitzherbert 1753-1839), British Ambassador to Spain in 1790-1794, who negotiated the Nootka treaty in Madrid."

Vancouver made no mention of volcanic activity as he almost certainly would have, had there been any, considering "the clearness of the atmosphere." Yet about this same time, plus or minus a year or two, a mountain of the Cascade Range (probably Mount St. Helens) is said to have expelled ashes to a depth of six inches somewhere in eastern or east-central Washington.

Charles Wilkes, in his 1845 report of an exploring expedition of 1838-1842, tells of a sixty year old Spokane Indian named Cornelius or
Bighead who told Wilkes in 1841 about experiencing this ash fall. "Cornelius, when about ten years of age [about 1791 more or less], was sleeping in a lodge with a great many people, and was suddenly awakened by his mother, who called out to him that the world was falling to pieces. He then heard a great noise of thunder overhead, and all the people crying out in great terror. Something was falling very thick, which they at first took for snow, but on going out they found it to be dirt: it proved to be ashes, which fell to the depth of six inches..." (Holmes 1955: 201).

The Spokane Indian lived in northeastern Washington but ranged as far west and south as Celilo Falls on the middle Columbia River. This event could have happened anywhere between present-day Spokane and Celilo Falls, but most probably nearer the former and it was apparently in the early 1790s either shortly before or shortly after Vancouver's visit.

Indian stories are often discredited in historic accounts but it has been my experience that they are usually based in fact. In this instance the man related an event that he had experienced and I see no reason to doubt it. Nor do I see any reason to doubt Wilkes' relation of the account. The geologist, James D. Dana, who was on the Wilkes expedition supports the account when he states: "...an account is on record of ashes falling fifty years since" (Holmes 1955: 198).

I find no record of volcanic activity of Mount St. Helens in the Lewis and Clark journals of their 1804-1806 trip along the Columbia (Thwaites 1904-1905). The botanist, David Douglas, in June 1825 described Mount St. Helens as 10,000 or 12,000 feet high and "...two thirds are continually wrapped in snow. ...immense barriers of ice rendering every attempt to reach the summit quite impracticable." He made no mention of volcanic activity (Douglas 1904: 246). Likewise, the journal of John Ball recounting his trip from Missouri to the Oregon country, on November 3, 1832 mentioned Mount St. Helens but said nothing of volcanic activity (Powers 1902: 98). All of these travelers were good observers of natural phenomena and would be expected to record a volcanic event if they had known of it.

The second record of an eruption that I find that may be attributable to Mount St. Helens is of the spring of 1831, though it was recorded in 1835. Dr. Meredith Gairdner, medical officer for the Hudson's Bay Company at Fort Vancouver from April 30, 1833 to late September 1835, described an eruption of Mount St. Helens during March 1835. In this description he also states: "At the same season in the year 1831, a much denser darkness occurred here, which doubtless arose from the same cause, although at that time no one thought of examining the appearance of this mountain" (Holmes 1955: 203). Obviously Gairdner did not witness the 1831 event but compared hearsay about it with the 1835 eruption concluding that the 1831 event was an eruption of Mount St. Helens and a greater one than that of 1835.

Gairdner is supported by a diary entry of October 16, 1835, by the American missionary Samuel Parker at Fort Vancouver. He states: "Mount Helens has a volcano, which at different periods down to the
present time, is in operation and sends forth smoke and fine cinders to a considerable distance. Its last eruption was in 1831" (Holmes 1955: 203). He here implies several eruptions prior to 1831 but is unclear as to whether he knew of the one of March 1835. He at least seems certain that there were no eruptions between 1831 and 1835.

Gairdner's description of the event of March 1835 appears to be, as he states, the first record of observed volcanic activity on Mount St. Helens. His undated letter was apparently written in late March or early April, 1835, as he had been ill in March and "A proposal to climb Mt. St. Helens, then in volcanic eruption, had to be abandoned" (Holmes 1955: 202). Gairdner's description states: "We have recently had an eruption of Mount St. Helens, one of the snowy peaks of the Marine Chain on the north-west coast, about 40 miles to the north of this place (Fort Vancouver). There was no earthquake or preliminary noise here: the first thing which excited my notice was a dense haze for two or three days, accompanied with a fall of minute flocculi of ashes, which, on clearing off, disclosed the mountain destitute of its cover of everlasting snow, and furrowed deeply by what through the glass appeared to be lava streams. There was no unusual fall of the barometer at this place. I believe this is the first well ascertained proof of the existence of a volcano on the west coast of America, to the north of California on the mainland. At the same season in the year 1831 a much denser darkness occurred here, which doubtless arose from the same cause, although at that time no one thought of examining the appearance of this mountain" (Holmes 1955: 202-203).

It was unfortunate that Gairdner's health compelled him to leave the area in late September 1835, preventing his continued recording of the mountain's activity. However, there appears to have been nothing to record for the next seven and a half years. Between March and late September 1835 Gairdner left no record of volcanic action. The journal of Narcissa Prentiss Whitman, one of the first two American white women to cross the Rockies to the Oregon Country, on August 29, 1836, mentioned Mount Hood and Mount St. Helens as "lofty peaks...of a conical form..." but indicated no volcanic action (Elliott 1936: 95, 96). The journal of John H. Frost on Saturday, May 29, 1840 noted: "When we arrived off the lower mouth of the Willamette, Mt. St. Helen stood to the North of us, with its round snow caped top towering above the clouds, presenting a most sublime appearance" (Pipes 1934a: 53). A "sublime appearance" would seem to indicate no volcanic activity.

The next volcanic episode appears to have taken place in the winter of 1842 and is called by Holmes (1955: 203) "The great eruption" of the winter of 1842. It appears to have been a long series of events lasting about 25 months, from November 22, 1842 to December 28, 1844.

Josiah L. Parrish, a Methodist missionary "...in the old Mission house, ten miles below Salem..." observed the initial burst of activity on November 22, 1842. He is quoted by J. Quinn Thornton, in 1849, as stating "...that no earthquake was felt, no noise was heard, and that he saw vast columns of lurid smoke and fire shoot up; which after attaining to a certain elevation, spread out in a line parallel to the plane of the horizon, and presented the appearance of a vast table,
supported by immense pillars of convolving flame and smoke" (Holmes 1955: 205). Parrish is also quoted as saying that the location of the vent was "...on the south side of the mountain, about two-thirds of the distance from the bottom to the top" (Holmes 1955: 205). Ten miles below Salem would put Mr. Parrish approximately 95 miles south-southwest of the mountain. The view might well have been somewhat obscured by intervening terrain and timber but this is almost exactly the distance from which Vancouver viewed the mountain when he named it although in a different direction. Parrish further states: "I had occasion to pass down the river about a year or two after the eruption, and could still see distinctly the fire burning upon the side of the mountain" (Holmes 1955: 205).

Henry Bridgman Brewer, a Methodist missionary at The Dalles, on the Columbia River, recorded the same event. In his diary of November 25, 1842 he noted: "This morning was memorable for the shower of sand supposed to come from Mt. St. Helens or Hood" (Holmes 1955: 204). Obviously he did not see the eruption, though some 30 miles nearer than Parrish, but did experience the ash fall 65 miles from the volcano, at The Dalles.

Brewer's experience was confirmed a year later by John C. Fremont. On Fremont's great pathmarking expedition of 1843-1844 he noted in his journal on November 13, 1843: "Wherever we came in contact with the rocks of these mountains, we found them volcanic, which is probably the character of the range; and at this time, two of the great snowy cones, Mount Ragnier and St. Helens, were in action. On the 23rd of the preceding November, [1842, almost exactly a year previous] St. Helens had scattered its ashes, like a light fall of snow, over The Dalles of the Columbia, 50 miles distant. A specimen of these ashes was given to me by Mr. Brewer, one of the clergyman at The Dalles" (Fremont 1845: 193-194).

I may now return to John H. Frost who, as noted above, commented on the "sublime appearance" of Mount St. Helens on May 29, 1840. This Methodist missionary again remarked, almost three years later, on his observation of the mountain as well as of that of a comet. On March 19, 1843, his journal records: "...For two nights past, a Comet with a train extending about one fourth of the distance across that part of the heavens which is visible to us, with a bright twinkling star at its head, has been seen by all of us. It was discoverable at sun set, or soon after, in the west, and last night it set so that its train was entirely lost to us beneath the western horizon about a quarter after 9 o'clock in the evening, its course being in the direction of the Sun or nearly from east to west" (Pipes 1934b: 373). This, of course, has nothing to do with Mount St. Helens but serves to illustrate Mr. Frost's observation of unusual natural phenomena.

He continues in his journal of the same day: "I will now mention that when I attempted to ascend the river to Vancouver on the 13th December last, I observed a column of smoke to ascend from the N.W. side of Mount St. Helens, toward the top; of which I thought at the time that it was a perfect resemblance of a volcanic eruption, but as I had no one but Indians with me, consequently no one with whom I could
reason on the subject, I dismissed it from my mind, and thought no more of it until it was mentioned by some other person who had witnessed the same phenomenon. It has been ascertained since, however, that it was an actual volcanic eruption. I know not that it has as yet emitted anything but smoke. Have learned since that ashes has been thrown out in great abundance, even as far as to The Dalles" (Pipes 1934b: 373-374).

This is interesting in that he was not sure, on December 13, 1842, that it was a volcano but confirmed his thoughts on it later by hearing others tell of it. His reference to the "ashes" at "the Dalles" may have referred to the November 22, 1842 eruption or to any eruption between then and March 29, 1843. His inability to "reason on the subject" with the Indians who accompanied him may reflect only a language barrier but appears to indicate his concept of these Indians as something less than people and with whom to "reason on the subject" would not be possible. In either event he probably missed a fine opportunity to really learn something about what he was seeing.

Overton Johnson and William H. Winter published their memoirs of an overland "Migration of 1843" from Independence, Missouri, to the Oregon Country and upper California. In the latter days of October 1843 they were at the Wascopin Methodist Mission some three miles below the Dalles on the Columbia River. "A short distance below the Mission, we found the stumps of trees, standing erect in ten or fifteen feet water, as if a dam had been thrown across the River, and the water backed up over its natural shores. We asked the Indians if they knew how these stumps came to occupy their present position, but none of them were able to inform us. They had a tradition among them that long ago the Columbia, in some part, ran under the ground, and that during an eruption of Mt. St. Helens the bridge fell in" (Johnson and Winter 1906a: 98-99).

Specific dates in this account of the "Migration of 1843" are difficult to identify but apparently sometime in November 1843, Johnson and Winter again mention Mount St. Helens. "Twenty-five miles North from Vancouver, and about opposite the mouth of the Willamette, Mount St. Helens, a lofty snow-capped Volcano rises from the plain, and is now burning. Frequently the huge columns of black smoke may be seen, suddenly bursting from its crater, at the distance of thirty or forty miles. The crater is on the South side below the summit. The Cawilz River has its source in Mount St. Helens" (Johnson and Winter 1906b: 175). Later on, in the general description of the country, they state: "...and further to the North St. Helens shows her towering crater of eternal fire" (Johnson and Winter 1906b: 198).

The account of the stumps in the water "...as if a dam had been thrown across the River..." is one of many references to the legend of "The Bridge of the Gods" (Clark 1952; Balch 1965). This reference, however, specifically identifies the cause of the collapse of the legendary "bridge" over the Columbia River as "...an eruption of Mt. St. Helens...", though obviously an eruption of a long time, probably many centuries, previously. This legend, perhaps based in some degree of fact, was apparently commonly accepted along the Columbia River in the mid-nineteenth century.
The second and third mention of Mount St. Helens by Johnson and Winter cannot specifically be dated. It is clear that it is after late October 1843 when they passed the Wascopin Mission and perhaps prior to November 13, 1843 when they reached Oregon City. It could, however, have been between their arrival at Oregon City and their leaving for California on the 18th of June 1844. If the latter, it was probably several months before June 1844. In any event the clear implication is that Mount St. Helens was in a state of frequent eruption during this period and was a "...towering crater of eternal fire..."

This is supported by other observers of this same period. A letter written by Peter H. Burnett from Linnton, Oregon Territory on December 28, 1844, states "From Linnton you have a very fair and full view of Mount St. Helena, about fifty miles distant; but it looks as if it was within reach. This peak is very smooth and in the form of a regular cone, and nearly, if not quite, as tall as Mount Hood, and also covered with perpetual snow. This mountain is now a burning volcano. It commenced about a year since. The crater is on the side of the mountain, about two thirds of the distance from its base. This peak, like Mount Hood, stands far off and alone, in its solitary grandeur, rising far, far above all surrounding objects. On the sixteenth of February, 1844, being a beautiful and clear day, the mountain burned most magnificently. The dense masses of smoke rose up in one immense column, covering the whole crest of the mountain in clouds. Like other volcanoes, it burns at intervals. This mountain is second to but one volcanic mountain in the world, Cotopaxi, in South America. On the side of the mountain, near its top, is a large black object, amidst the pure white snow around it. This is supposed to be the mouth of a large cavern. From Indian accounts this mountain emitted a volume of burning lava about the time it first commenced burning. An Indian came to Vancouver with his foot and leg badly burnt, who stated that he was on the side of the mountain hunting deer, and he came to a stream of something running down the mountain, and when he attempted to jump across it, he fell with one foot into it; and that was the way in which he got his foot and leg burned" (Burnett 1902: 423-424).

Burnett, here, provides the first firm evidence of a lava flow. He also confirms intermittent eruptions throughout 1844 with an especially heavy eruption on February 16, 1844, but still "a burning volcano" on December 28, 1844.

During the same year the diary of the Reverend George Gary also records this volcano. Reverend Gary's part, in a sailing ship, making very difficult progress under a light wind, sailed up the Columbia River some 25 or 30 miles beyond Pillar Rock. On Thursday, May 30, 1844, he records in his diary: "We have a very distant view of a volcano in action, throwing up clouds of smoke. For some days we have seen Mount Helen [St. Helens] which is covered perpetually with snow; this volcano as it appears so far off seems to be near it, but I am not able to form an opinion whether this volcano is near enough to melt the perpetual snows or not. On further inquiry I have learned that this volcano is in Mount Helen itself, and that either the snow is diminishing or the soot settling upon the white covering of the mountain presents the appearance of wasting snow. It is so cold near these
snowy mountains and the snow is so deep I believe there has been no very thorough examination of them, and this volcano is so high up the mountain as that the temperature at its base is but little, if any, affected by it. The falling ashes or soot have been seen and gathered from boards or anything of a smooth surface, say, fifty miles from the crater" (Carey 1923: 76-77).

The next record I find is that of the Canadian painter of western scenes, Paul Kane. He was, on March 26, 1847, at the mouth of Lewis River some 35 miles from the peak with an excellent view of Mount St. Helens. "There was not a cloud visible in the sky at the time I commenced my sketch, and not a breath of air was perceptible; suddenly a stream of white smoke shot up from the crater of the mountain, and hovered a short time over its summit; it then settled down like a cap. This shape it retained for about an hour and a half, and then gradually disappeared" (Holmes 1955: 206-207). Kane later turned his sketch into a painting showing the eruption coming from a vent about two thirds the way up the north side of Mount St. Helens.

On April 1, 1848, Robert Caufield of Oregon City wrote in a letter to his brother John in Ireland, that: "St. Helens which's still a volcano and continually covered with snow stands...about 70 miles north of this place [Oregon City]. There has been two emptyings of this mountain since we came here [there is no indication of when he came there]. The report we could hear distinctly and the reflections seen in the sky at night. The Indians have a contradiction that 'A long time since that a great fire commenced in the south and kept going north and is still burning' which is true and about 4 to 5 hundred miles over which we traveled had the appearance of being burned goes to prove it" (Holmes 1955: 207).

The diary of the Rev. George H. Atkinson, D. D., on June 17, 1848 records that: "Mts. St. Helens and Rainier and Hood are magnificent cones rising high above all others and covered with perpetual snows" (Rockwood 1939: 179). He makes no mention of any volcanic activity.

On March 21, 1850, the pioneer Oregon City newspaper, the Spectator reported that both Mount St. Helens and Mount Baker were showing some volcanic activity and that Mount St. Helens was emitting smoke from two craters "low down on the north and northeast sides" (Holmes 1955: 208). On May 10, 1850, the same newspaper stated that "Mt. St. Helens is at present in a state of eruption" (Holmes 1955: 208).

A letter of November 9, 1852 from Charles Stevens, written from Milwaukie, Oregon Territory (just west of Portland) referred to his observation of the previous June (or July). He mentioned his view of "Mount Reiner Mount Hood & Mount St. Hellen, all covered with snow, being some 16 or 1800 feet high" (Rockwood 1936a: 149). Another letter from Charles Stevens from Milwaukie on January 3, 1853 remarked that Rainier, St. Helen, and Mount Hood are covered with snow and are "between 16 and 18 thousand feet high." He further states: "Now Mount St. Hellen & Mount Hood are said to be volcanoes, (I have seen no signs of it thou), and the Indians say that there used to be a natural bridge over the river at the Cascades, but these two mountains got into a
fight and threw it down, and it appears to me that the appearance of
the mountain does in some way justify the story" (Rockwood 1936a: 157-
158). In neither of these letters is volcanic action noted, in fact he
specifically states that he has "seen no signs of it."

Stevens again wrote from Milwaukie on April 10, 1853 and here he
records the volcano. "Lydia, On the opposite side of this I have
drew a little sketch of Mount St. Hellen, as it appears way down in
the mouth of the Columbia River, it is not correct, but it will let you
see how these mountains look. Where I drew the sketch, is about two
hundred miles from the mountains, and I suppose it might be seen one
hundred miles out at sea.

"The little black spot near the top is a hole, where the fire and
smoke comes out. It runs way up above the clouds, as you will see the
spots near the bottom looks like black lava. Mount Hoods shape is
nearly the shape of this. The river in the picture is the Columbia"
(Rockwood 1936b: 251). Now Stevens not only mentions the eruption but
draws a sketch of it. His estimate of distance is about double the
actual distance from which he viewed the eruption but his sketch is
clearly in keeping with other descriptions of volcanic events on Mount
St. Helens. He places the vent about one fourth the way down the south
side of the cone.

On September 3, 1853 the Portland Oregonian recorded the first
ascent of Mount St. Helens under the leadership of the first editor of
that newspaper, Thomas J. Dryer. This article particularly noted the
location of the vent at that time: "The crater has been represented to
be on the southwest side of the mountain, which is not the case. We
took the bearing from the top of the compass, and found it to be on the
northeast side. The smoke was continually issuing from its mouth,
giving unmistakable evidence that the fire was not extinguished"
(Holmes 1955: 208-209).

Nearly six months later the Oregonian again reported a volcanic
Helens has been unusually active for several days past. Those who have
been in a position so as to obtain a view of the mountain, represent
clouds of smoke and ashes constantly rising from it. The smoke appears
to come up in puffs, which was the case at the time we visited it in
August last. There is now more smoke issuing from it than there was
then, which indicates that the volcanic fires are rapidly increasing
within the bowels of this majestic mountain" (Holmes 1955: 209).

The eruption of February 25, 1854 was also noted by the Oregon
Weekly Times of that date: "We learn from Mr. W. H. H. Halls, Esq.,
pilot of the Whitcomb [a Columbia river steamer] that he witnessed an
eruption of Mt. St. Helens on the last trip down of the steamer Whit-
comb. The volumes of smoke which were thrown out at intervals left no
doubt in his mind but that an eruption had taken place" (Rockwood 1937:
73).

Charles Stevens also recorded this event in his letter of March
27, 1854 when he noted: "Mount St. Hellen was on fire some 4 or 5
weeks ago, but we did not have the pleasure of seeing it, for we cannot see it from our house" (Rockwood 1937: 73). Stevens wrote that letter from Portland.

The last report of activity of which I am aware, until 1980, is to be found in a newspaper story from the Steilacoom Republican of April 17, 1857. Steilacoom is near Tacoma, Washington, some 65 miles north northwest of Mount St. Helens. "Mount St. Helens, or some other mount to the southward, is seen from the Nisqually plains in this county, to be in a state of eruption. It has for the last few days been emitting huge volumes of dense smoke and fire, presenting a grand and sublime spectacle" (Holmes 1955: 209).

With this the long episode of nineteenth century volcanic action on Mount St. Helens came to an end until her internal unrest exploded again one hundred and twenty three years later. Perhaps the Indian story told to George Gibbs, while surveying for a northern railway in 1854, bears remembering. "Mount Hood and Mount St. Helens, they said, were man and wife. They quarreled and threw fire at one another, St. Helens [the wife] being the victor. Since then Mount Hood has been afraid, for St. Helens has a strong heart and still burns" (Clark 1952: 35).

As I have said, this is but a note about the 19th century volcanic activity of Mount St. Helens. I am sure that a more exhaustive search of the literature, especially early newspaper accounts, would turn up additional references. For example, the Notes and News in the Oregon Historical Quarterly of December 1954, page 343, reads "A list of eruptions is part of 'Recent Geological News tells of Mt. St. Helens Eruptions,' in the St. Helens Sentinel-Mist, October 26." Volume 56, No. 1, March 1955, of the same Quarterly, in Notes and News, states that: "Descriptions of Illumination Rock and Coe and Eliot glaciers on Mount Hood appear in the December 1954 Mazama, as well as some geologic history of Mount St. Helens eruptions." These were not available to me and, as is to be seen, my main source of information has been from the Oregon Historical Quarterly supplemented by a few original sources. For the most part, the Oregon Historical Quarterly sources are reprinted or edited original sources, too. I am, indeed, grateful to this fine journal for its contributions to knowledge. I am also grateful to Robert L. Ogle of Lakeview, Oregon, for making a full set of the first 50 or so years of this journal available to me and to my wife, Georgie, for first sorting these references out for me.

An excellent volume that deals with dating, chronology, stratigraphy, volcanic activity and with the impacts of volcanism on animals, plants, human populations and the environment deals with Mount St. Helens to a limited extent (Sheets and Grayson 1979). Dr. Mullineaux's article in that volume (p. 195) lists and discusses many of the volcanic events of that mountain during the Holocene but does little to document the nineteenth century eruptions (pp. 204, 205-206).

I believe that, though not exhaustive, this listing of the events of more than half a century of fairly continuous volcanic activity on Mount St. Helens may prove to be of some predictive value. There is no
way to even suggest that because a series of events happens once it will happen again. One time does not make a pattern. On the other hand, there are very few other predictive mechanisms for trying to second-guess a volcano, despite the many advances in recent decades within the geological and geophysical sciences. Historical perspective might at least provide some suggestions that may aid other predictive mechanisms and certainly should be worth considering.

Between the early 1790s and April 17, 1857, there seem to have been nine, more or less, separate volcanic events. A major one seems to have occurred in the early 1790s sending ashes over eastern Washington. There were none apparently recorded for the next 35 or 40 years, although one reference implies that there were several. The second recorded eruption occurred in March, or thereabouts, of 1831, but apparently this was but a single event with no activity for the next four years. The third event spewed ash, smoke and lava in March 1835. Again a dormant period seems to be on record, lasting seven and a half years.

The "great eruption" of the century, the longest lasting and the best recorded, occurred on November 22, 1842. There appear to have been intermittent eruptions throughout the rest of that year, and the next and extending to December 28, 1844. No less than seven major events are on record and there are frequent references to "continuous" or "intermittent," or "frequent" eruptions during this period of approximately 25 months. There appear to have been at least several dozen minor and major events ranging from brief puffs of smoke to major eruptions of lava.

Less than three years later, on March 26, 1847, a fifth eruption took place with a sixth eruption on April 1, 1848, almost a year later. There is, though, no record that I found that there were not any eruptions between these dates.

Then on March 21 and again on May 10, 1850 there were two reports of eruptions, which I am lumping together as the seventh event. In June 1852 and again in January 1853, there were reports that suggested that no volcanic activity was taking place. But on April 10, 1853, the eighth eruption is recorded. This series seems to have been continuing in September 1853 and on until February 25, 1854. These several events may be lumped together as the eight event. Then quiet again for more than three years.

The final event of the nineteenth century volcanic episode on Mount St. Helens took place on April 17, 1857. The angry wife had vented her wrath and quieted down for the next 123 years. Let us hope that the events of March, April, May, June and July, 1980, which appear to have been a great deal more severe than any of the nineteenth century events, will assuage her present wrath and that she will rest quietly for another century or two.
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