Correlations Between Catastrophic Paleoenvironmental Events and Native Oral Traditions of the Pacific Northwest

by

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Abstract

The indigenous populations of the Pacific Northwest have consistently maintained that proof of their long occupation in their traditional ethnographic territories is embedded in their oral traditions. These oral accounts are the primary methods for recording indigenous epistemology and history. From a native perspective, historical references contained within oral traditions are considered factual. However, the western scientific community has not been as accepting of oral traditions, as actual accounts of the past. Geologists, archaeologists and physical anthropologists tend to revert to western science when reconstructing the past.

Native groups claim that information within their oral traditions is historically accurate. Therefore, one may presume that a comparison between oral traditions and scientifically known prehistoric and historic events would lead to similar interpretations. Past catastrophic environmental events (such as volcanic eruptions, earthquakes, landslides, tsunamis, floods, etc) with discrete, recognizable attributes, may serve as benchmarks for comparison to prehistoric references contained within oral traditions. For the most part, geologists have provided us with a specific range of dates and magnitudes for such events. In addition, such events, even of considerable age, would likely have been significant enough for a lasting record to be maintained by the indigenous population(s) in their oral traditions.

This study examines the relationships between the following three specific catastrophic paleoenvironmental events and native oral traditions that apparently refer to them: (1) the Mount Mazama climactic (or 'caldera-forming') eruption, 6850 b.p.; (2) the Bonneville/Cascade landslide, 900-400 b.p.; and (3) the megathrust earthquake related tsunami, 300 b.p.. The historical literature pertaining to indigenous groups (specific to each event) was reviewed for oral traditions that may refer to the event in question. Through the use of qualitative tables, relationships between the geological and archaeological evidence and the event depicted in the oral tradition are shown to exist. Moreover, a 'qualitative measure' is employed in a descriptive fashion, where a distinction is made between clear relationships and less obvious ones.

Perhaps such an evaluation of a portion of the indigenous perspective within a western scientific framework may serve as a foundation for further work in this area. Eventually, a combination of the two perspectives may yield a richer, more holistic view of the past.

"Not everything that can be counted counts,
and not everything that counts can be counted"

Albert Einstein

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Lastly, a thought for my best friend and dear wife Sherri, who is tired of hearing the word "thesis". Thank you for your love, patience and support.

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Introduction

As with other academic disciplines, archaeology today is changing to keep current with society's demands. As a result of recent court cases in both Canada and the United States, First Nations groups are gaining significant influence over how anthropologists and archaeologists study their culture and history. This is an important stage in our development as a discipline, as archaeologists become accountable for their work to both academia *and* any involved First Nations groups.

Some archaeologists and indigenous peoples of North America have had a 'confrontational' relationship regarding the interpretation of the past (Biolsi and Zimmerman 1997a; Deloria Jr 1995; Ignace et al. 1993:167; Thomas 1999, 2000; Wilson 1995, 1997). If we examine this relationship on a macro scale, it is easy to observe how controversies and misunderstandings have arisen. Indigenous peoples have their own history and perceptions of their place in the world, recorded and transmitted in the form of oral traditions. These oral traditions often record the epistemology of a group, in addition to their interactions with past peoples or environmental events (Biolsi and Zimmerman 1997b). They are as real and accepted by traditional First Nations peoples as science is to the modern western scientific community. However, it can be argued that their past is not really "theirs", in the sense that their history now has been recreated by outsiders with little or no knowledge of indigenous culture – or worse, with no desire to acquire or understand indigenous culture. In other words, indigenous peoples have often had their past recreated by outsiders who have neglected to consult or involve them in the process. Those archaeologists often appear to assume a position of arrogance and ethnocentricity by imposing their own beliefs upon indigenous people (Biolsi and Zimmerman 1997a). Basically, native Indian history has been dominated by non-native academics to create

non-native interpretations about native North American Indians and their pasts (Wilson 1997:101).

Thus, in order to truly grasp a richer, more complete perspective of the North American Indian past, native sources must be consulted by academics. In order for native beliefs and archeology to work in collaboration with one another in reconstructing the past, we must discover a common ground. Native peoples retell their past using oral traditions, while the western scientific community uses history and archaeology. Are our realities so distinct that a common ground cannot be obtained? Likely not, but rather than having native peoples accept and conform to our methods and practices of reconstructing the past, archaeologists also should attempt to understand native perspectives. This may be achieved through the examination and critical evaluation of oral traditions as potentially valuable historical records.

Oral tradition is a part of many cultures, but it is an especially important part of native North American culture. For thousands of years, native people have passed on stories of their lives in a continuous succession, from one generation to the next. This practice continues today, despite the predominance of written communication. Native North American storytelling is an oral tapestry, weaving culture, history and folklore together as one.

Inherent in oral traditions are 'messages from the past', which should be of interest to archaeologists. Essentially, in interpreting the prehistory of North America, there exist two worldviews: the native (or indigenous) account and the western scientific interpretation. While these two worldviews are very different from one another, they converge in a broad sense on certain issues and themes, such as migrations, warfare, residential mobility, land use and ethnic coresidence. It is crucial for archaeologists to understand *how* and *why* these accounts converge or differ on particular issues. Clearly, there are unanswered questions regarding the history and prehistory of North America in

both epistemologies. Within archaeological explanation there also exist opposing theories often based on weak scientific evidence, but traditionally never including indigenous interpretations. Of course, archaeological data are limited, and archaeologists rely on information from other disciplines, such as geology, chemistry, geography, psychology, sociology, anthropology, etc., in interpreting the past. If archaeologists can take the time to understand and interpret evidence from these other disciplines, then we should also try to understand native philosophy and oral traditions. Native philosophy offers alternative ideas about the past that "counter our tendency to portray everyone in all time as versions of ourselves" (Gazin-Schwartz and Holtorf 1999:5). The result can only enrich archaeological interpretation. Archaeology might also be used to fill in gaps that exist in native interpretations of the past. Thus, the often 'rocky' relationship between archaeologists and natives may be improved with this mutual respect and acceptance of each other's accounts.

Historical Background

Historically, there have been some attempts to use oral traditions in archaeological interpretation. In the nineteenth century, archaeology and folklore (in which oral traditions may be categorized) began to define themselves as discrete disciplines. Archaeology became "the realm of physical monuments and material remains of the past, while folklore focused on verbal performances and customary activities" (Gazin-Schwartz and Holtorf 1999:8). In North America, native peoples who maintained their histories and origins through oral traditions were thought to have had a 'static' existence. And, if any sort of complexity was observed, it was thought to have migrated from more 'civilized' areas (Trigger 1989:123-126). Natives were seen as disappearing, thus there was urgency for ethnologists and archaeologists to recover and record their customs, stories and cultural remains. Archaeologists used ethnographic analogy to explain prehistoric archaeological

data. When migration could not be used as an explanation, the initial consensus was that any social organization or material culture that existed in the nineteenth century had existed that way in the past. (Trigger 1989, Gazin-Schwartz and Holtorf 1999). It was thought that since native people had not changed over time, they did not have much of a history, nor, by implication, much of a future.

During the twentieth century, archaeology began to distance itself from folklore. There was an emphasis on methodological and technological aspects, such as excavation and dating. The theoretical approaches also followed this trend. In the meantime, folkloric studies were moving in the opposite direction. They went from treating oral traditions as historical artifacts, to analyzing them in a cultural, behavioral and literary manner, drawing on such disciplines as anthropology, psychology and literary studies (Gazin-Schwartz and Holtorf 1999). Only towards the end of the 20th century, with the post-processual movement, did technical and scientific aspects less dominate archaeology, permitting a 're-convergence' with the information inherent in oral traditions.

The primary concern that archaeologists have had about the use of oral traditions in reconstructing the past is their historical accuracy. But rather than simply rejecting oral traditions as inaccurate and unreliable, they still should be analyzed, just as a varied range of other 'archaeological materials' must be analyzed. Only then, as many authors (e.g. Brown and Bowen 1999, Champion and Cooney 1999, Cruikshank 1995, Deloria Jr. 1995, Green 1999, Layton 1999, Partnow 1995, Schneider 1995, Shankland 1999, Staeck 1999, Symonds 1999, Wilson 1997, Yellowhorn 1996, and others) have shown, oral traditions may provide plausible interpretation (Gazin-Schwartz and Holtorf 1999:5). A First Nations group, the Gitksan, and the Canadian legal system illustrate an excellent example of the importance of this notion. Moreover, this example shows us a glimpse of how academia, the Canadian legal system, oral traditions and popular society can be intimately interconnected.

Oral Tradition within Canadian Law

Recently within the Canadian court system, there have been several precedent setting cases regarding aboriginal rights and title (such as Sparrow, Vanderpeet and Delgamuukw). As well, First Nation epistemology has been given a favorable response within the courts. In R. v. Sparrow, [1990] 1 S.C.R. 1075 (S.C.C.), the Supreme Court of Canada recognized the existence of aboriginal rights in Canada (note: "R" refers to "Regina", or the Queen which indicates that the particular proceeding was initiated by the government, as opposed to an individual). In addition, the court in R. v. Vanderpeet (1996), 137 D.L.R. (4^{th}) 288, enunciated a test whereby aboriginal rights can be objectively assessed in order to determine whether or not the right asserted by an aboriginal group is an aboriginal right and thereby protected by Section 35(1) of the Constitution. In this regard, an aboriginal group is required to demonstrate that the practices, customs and traditions that constitute an aboriginal right have 'continuity' with their customs and traditions that were practiced prior to European contact. It is at this stage of the Vanderpeet analysis where oral traditions and archaeological interpretations are received as evidence. The 'Vanderpeet test' has become widely recognized and was referred to in the case of Delgamuukw v. British Columbia, [1997] S.C.J. No. 108, unreported, Dec. 11, 1997.

Of all the First Nations court cases that have occurred to date, the most significant and renowned is the Delgamuukw case. The Gitksan and Wet'suwet'en First Nations commenced the Delgamuukw court action in 1984. It went to trial in 1987 with judgment given in 1991. The British Columbia court of Appeal heard an appeal in 1993, and a further appeal was taken to the Supreme Court of Canada, which rendered its decision in December 1997 (Bennett 1999). The Supreme Court of Canada overturned the decision based on the grounds that the trial judge had not given the oral history evidence of the plaintiffs the necessary evidentiary weight.

There were three primary forms of oral evidence that the First Nations plaintiffs presented. First, there was testimony of aboriginal life within the claimed territory. The second form consisted of affidavits provided by the hereditary chiefs, regarding the boundaries of the land owned by each house. Finally, elders recounted the oral traditions of the Gitksan and Wet'suwet'en: named the "Adaawk" and "Kungax".

The Seeley Lake Medeek was the only aboriginal narrative that was reproduced in the trial judgment. The aboriginal plaintiffs chose to submit the Seeley Lake narrative to the court as a fundamental example of how meaning could be associated with the Adaawk and Kungax (Bennett 1999). The plaintiff's belief was that the Seeley Lake Medeek was the expression within the Gitksan culture of the recollection of a distinct paleoenvironmental event that could be identified and dated using conventional scientific methods. During their opening statement, as stated in the Address of the Gitksan and Wet'suwet'en Hereditary Chiefs to Chief Justice McEachern of the Supreme Court of British Columbia [1988] 1 C.N.L.R. 17 at 34-35, the aboriginal plaintiffs focused on this narrative and the potential conclusions that the court should draw from it.

> For example, the Gitksan ada'ox of Medeek describes the destruction of Tamlaxam by a terrible force, which ripped through the forest bringing down trees in its wake and causing a rapid rise in the waters of a nearby lake. This destructive force is attributed in the ada'ox to a giant grizzly bear. The ada'ox describes this in graphic detail. Using the detail of the account in terms of the nature of the event and its physical location, "scientific" evidence will be presented relating this event to a landslide or debris flow that occurred in what is now known as the Chicago Creek drainage, accompanied by the damming of and rise in the waters of Seeley lake. This event occurred, according to the scientific evidence, some three thousand five hundred years ago.
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> . . .
>
> Because we have no written account of the landslide at Stekyooden...must the court view the scientific geological and archaeological evidence as the only real evidence of the time depth of Indian occupation of the territory? Must the plaintiffs' own accounts of the event that took place hundreds and thousands of years ago be deemed unscientific and mythical, mirages of reality, rather than the evidence of history?

However, the point is not to simply accept the oral tradition when it can be verified scientifically. In this case, there exists a significant catastrophic physical event that we can use as a benchmark to measure the accuracy and legitimacy of the oral tradition, within an academic perspective. What is more important is the meaning of the oral tradition, rather than its accuracy.

In the end, Chief Justice Lamer ruled that the trial judge had made an obvious error in connection with the treatment of the oral history evidence. He felt that the counsel for the plaintiffs sought equality of treatment of oral and written history, which was clearly not accepted by the trial judge (Bennett 1999). In direct contrast to Mister Justice McEachern's decision at the B.C. Supreme Court, Lamer's decision made it clear that oral histories are a legitimate form of judicial evidence.

As a result of this leading decision, the manner in which oral history and oral tradition is treated within the Canadian court system has been redefined. Within a broader context, it has influenced our political and economic infrastructure. The Delgamuukw decision also has inspired other First Nations right to title and land cases. In each pending case, the aboriginal plaintiffs will seek to have their oral evidence weighed in the same fashion that it was in Delgamuukw. But this decision reaches much farther than the immediate First Nations groups. Because it is centered on land claims, any discipline or industry that depends on land is affected. For example, archaeologists, geologists, and forestry companies (to name but a few) may find it increasingly difficult to acquire permission from native councils to work in designated areas. Subsequently, the resources that industries previously had access to utilize may become limited. Many resource industries are wary about making further investments in British Columbia because, unlike the rest of Canada, treaties cover few of the native groups. In most other provinces, native leaders long ago signed treaties settling the limits of their lands and formally extinguishing any hope for more (Ridington 1999)

There is also fear in many Eurocanadian residential communities, whose residents are concerned about the possibility of having their land repossessed by native groups. Before the Delgamuukw decision, Crown leases were protected from native land claims. Now, there exists an atmosphere of some uncertainty for those who live on land that has been claimed by the First Nations. Thus, this example illustrates the potential historical strength contained within oral traditions, and the profound effects that their interpretations may have on modern society.

Epistemological Differences/Differing World Views

As a result of the Delgamuukw decision, anthropologists and archaeologists will find themselves increasingly involved with the Canadian court system. Whether they serve as witnesses or interpreters of history, the role of the anthropologist and archaeologist has permanently changed (within Canada). Both will have the responsibility of interpreting oral traditions and elucidating their meaning(s) within a non-native framework. A good example of those inherently different perspectives is how our current concept of lineal time struggles to translate the cyclical, rather lucid nature of time that exists in oral tradition.

Basically, the situation involves inherently differing worldviews. The dominant western view believes that all can be explained through science. This perspective views knowledge as impersonal, since anyone with intellectual ability may acquire it. However, native perspectives view knowledge as personal and owned, where only those people given the ability by other entities can use it appropriately (Deloria Jr, 1995). Moreover, natives view the physical world as being 'alive' and interconnected (Deloria Jr, 1995:55; Wilson 1997) and perceive a spiritual activity that supports or underlies them. In contrast, the western scientist removes himself/herself as much as possible from the subject being

observed, for the purpose of objectivity, and tries to maintain minimal emotional involvement.

Therefore, we have two schools of thought, or two lines of inquiry to consider in reviewing native oral traditions. In the same way that within science, different theories, or data may be used together to better understand an event or concept, a complete interpretation of the past should involve multiple lines of inquiry. In other words, the different perspectives of modern archaeology and native oral traditions should be critically integrated as much as possible when interpreting prehistory and history. An apparent convergence between what science has 'proven' and what natives had traditionally believed conventionally, was explained by chance (Deloria Jr, 1995:49). Only recently has western science opened to the idea of including native interpretations into its understandings of the past. As science (more specifically archaeology) attempts to further understand native North American pre-contact history, it should look for ways that traditional native interpretations can be incorporated.

Using different perspectives in interpretation is not an uncommon practice within the social sciences, sometimes called 'triangulation' (Berg 1998:4). Berg states that:

> Every method is a different line of sight directed toward the same point, observing social and symbolic reality. By combining several lines of sight, researchers obtain a better, more substantive picture of reality; a richer, more complete array of symbols and theoretical concepts; and a means of verifying many of these elements. (Berg 1998:5)

As shown by this study, relationships between certain catastrophic paleoenvironmental events verified by science (firmly placed in time and space), and the oral traditions of some native groups are apparent, making it appropriate to adopt the concept of 'triangulation' when reconstructing their past.

Objective

The intent of this study is *not* to scientifically validate or verify the accuracy of all native oral traditions as a general class of information, within a western scientific perspective. It is simply an exploratory study that hopes to examine some possible relationships between various oral traditions and archaeological and geological data. Furthermore, it is important to note that this study is also not an attempt to 'decode' native oral traditions, nor is it an attempt to objectify, test or quantify what native North Americans hold sacred.

Within both archaeological and native interpretations of the past, there exists ambiguity. Since it is impossible to examine *all* of the events of the past, the question becomes; what *kinds* of events should be examined? Generally, events of great magnitude are better represented from both archaeological and native perspectives. That is because such events affected the greatest number of people, left the greatest physical evidence, and attracted the most attention. Some archaeologists have taken considerable interest in understanding past catastrophic environmental events of great magnitude, and their effect on local people. For example, some volcanic eruptions have been used to explain disappearances or migrations of past peoples, crucial to a greater understanding of regional prehistory (such as the White River Eruption in the Alaska-Yukon area 1200 years ago). Many other major Quaternary eruptions have been studied and documented for such reasons. It also is assumed that such events would have been significant enough to be recorded within oral traditions, depending on their proximity to specific groups and the antiquity of the event.

Thus, this study will examine relationships between native accounts of apparent catastrophic events, and the related Quaternary paleoenvironmental record in Northwestern North America. Volcanic eruptions, earthquakes, tsunamis, floods, landslides, rapid sea level fluctuations and rapid glacial advances/retreats, will be explored and discussed. Moreover, a detailed analysis will be conducted regarding three specific paleoenvironmental events, with large-scale regional impacts: 1) the main Mount Mazama eruption, 6850 b.p., 2) the Bonneville/Cascade landslide, 900-400 b.p., and 3) the megathrust earthquake and related tsunami, 300 b.p.. The geological and archaeological evidence of each event will be presented alongside the apparent native oral tradition, with any similarities examined. In addition, two research goals are explored: 1) To locate and test whether there exist any recognizable references within native oral traditions, to the above three catastrophic paleoenvironmental events, and 2) Is it possible to determine common elements between stories of like events (i.e. common thematic elements between landslide stories). If it can be demonstrated that there exist strong relationships between native oral traditions and discrete paleoenvironmental events that have been recognized in the established geological record, then the relevance of all oral traditions to our understanding of past native cultures and their histories would be strengthened.

Definitions

In order to be clearly understood, certain terms and concepts must be operationally defined. The term 'catastrophic', as used in this study, will refer to paleoenvironmental events of great magnitude that occurred virtually *instantaneously*. More specifically, it will refer to events that would have had either vast geographical consequences (such as large scale volcanic eruptions) and/or serious impacts on local human populations (as in the case of a tsunami). Relatively "gradual" events, such as

seasonal river floods, also may sometimes have had 'catastrophic' impacts on populations. However, the expectation is that those events that occurred instantaneously would have a greater chance of being recorded in oral traditions, and surviving over time. Secondly, the term 'correlation' (or 'similarity') must be addressed. Both geological evidence and a possible oral tradition of each event will be systematically categorized within qualitative tables. Therefore, there will be a table listing the individual characteristics for the geological/archaeological evidence, and again for the oral tradition (for each event), which will be compared against each other. Degrees of 'similarity' or 'difference' will be argued qualitatively and descriptively. A similar study to this one has been performed by Ruth Ludwin (1999: see internet resources) at the University of Washington, in which a qualitative analysis was used to elucidate shared story elements among different oral traditions possibly referring to megathrust earthquakes on the Northwest Coast of North America.

Scope

The three forementioned paleoenvironmental events all occurred within what can be termed the 'Pacific Northwest' region of North America, which stretches from southern Alaska to northern California, and as far inland as Idaho (figure 1). Although the 'Pacific Northwest' is primarily an American term, it best describes the geographic parametres of this study – as it includes such regions as the Northwest Coast and areas of the Plateau and Great Basin as well. It will be the geographical focus of this study. As one of the most geologically active regions on the planet, as well as having an indigenous human occupation that stretches back at least 11,000 years, the Pacific Northwest is an ideal environment for such studies. Catastrophic events (such as volcanic eruptions, landslides, floods, etc) have all occurred in abundance in this region during the Holocene,

which spans most of the time of established human occupation in the Pacific Northwest. Thus, there is considerable likelihood of there being local oral traditions describing such 'significant' Holocene paleoenvironmental events.

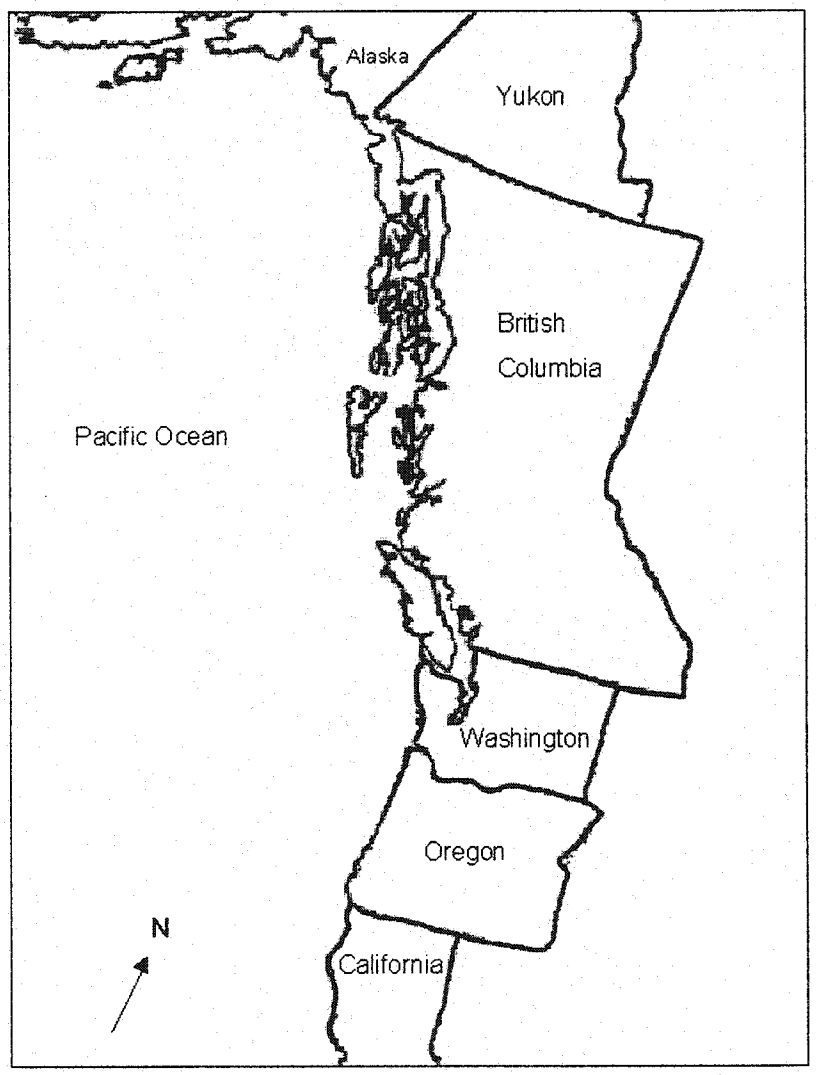


Figure 1: Map of Study Area

Methodology

As previously stated, the objective of this study is to test the degree of relationship between modern scientific knowledge of three catastrophic environmental events that occurred in the past and native oral traditions apparently related to them. Three different

events were judgmentally selected on the basis of their magnitude and potential impact on local human populations. The Mount Mazama climactic eruption at 6850 b.p., the Bonneville/Cascade landslide at approximately 850-350 b.p., and the megathrust earthquake induced tsunami (250 b.p.) were all the greatest of their kind in this region during the Holocene, and had significant, widespread environmental impacts. Thus, it was speculated that these events would have left the deepest impression on the communal psyche of indigenous peoples, thereby assuring their inclusion into their oral traditions.

A further reason that these particular events were selected is that they all were distinctive. For instance, the Mazama climactic eruption was not a common type of volcanic eruption, both in terms of its magnitude and its geological sequencing in relation to the Holocene 'Pacific Northwest'. This selection for 'distinctiveness' attempts to address the concern of interpreting standardized geologic descriptions from oral traditions. In other words, how do we know that the description of a volcanic eruption within an oral tradition is referring to one particular event, since most eruptions might have been recorded in a similar manner? This problem will be addressed further in the analysis section; however, it may be partly addressed by selecting clearly distinct environmental events, which should have been described very differently.

Data Collection

This study does not attempt to exhaust the entire literary base (i.e., ethnographies, recorded oral traditions, journals, notes, etc) pertaining to all the indigenous groups of the Pacific Northwest, in the hopes of locating all relevant oral traditions. A determination was made, based on various published opinions, regarding the ancestors of the modern native groups that were most likely to have lived within the immediate area affected by that event at the time it happened. In most cases, numbers were limited to the three most likely

groups, and lengths of occupation demonstrated archaeologically. Thus, for the climactic eruption of Mount Mazama, ca. 6850 b.p., archaeological and linguistic evidence suggest that the Klamath, Modoc and Shasta native groups were likely locally present during that event. Therefore, only the oral traditions of these three groups were searched for evidence of that particular event. Any that appeared to have a relatively clear description of a volcanic eruption were included in this study. Those oral traditions were then organized, categorized and compared.

Analysis

The analysis predominantly involves a qualitative comparison of the geological and archaeological evidence, with apparently related oral traditions. This will consist of both a descriptive section and a table format, which allows relatively simple, visual comparisons. For example, the Bonneville/Cascade landslide was certainly a catastrophic, paleoenvironmental event. However, it can be discussed in terms of several different stages, such as: a) pre-event – e.g. What was the environment like before the event occurred?, b) during the event – e.g. How much mass was displaced during the event?, c) post-event – e.g. What were the resultant geomorphological changes, and d) post-event adaptation – e.g. How was life for the local populations changed (environmentally) as a result of that catastrophic event? Then, the same treatment can be applied to apparently related oral traditions, with the same questions asked: Does the oral tradition mention what life/environment was like before the event? Is there any mention of the amount of mass that was displaced? Does it describe how life changed after the event?, etc. Any similarities, differences, and/or cross-cultural patterning (such as similar thematic elements within oral traditions from different groups) are then noted, analyzed and discussed.

Furthermore, oral traditions are read with an effort to elucidate both their 'manifest' and 'latent' content. In this case, 'manifest content' refers to elements that are physically present and countable, and 'latent content' involves symbolism potentially underlying the physical descriptions (Berg 1998:226). In other words, both surface structures and potential deeper structural meanings are considered. This is especially important when dealing with oral traditions due to their complex and multi-layered nature, which is covered in more detail in the *Oral Tradition; Metaphor and Meaning* section of this study – where *apparent* and *intended* meanings are discussed.

Inherent Biases

Any study involving judgmental sampling has inherent biases. This is especially true when attempting to interpret oral traditions from a non-native perspective. First, there is the issue of 'meaning', which can be briefly defined as social purpose and relevance. Since meaning is not fixed within oral traditions, when an oral tradition is recorded in print, it becomes static (Cruikshank 1990, 1998; Ong 1982; Vansina 1961,1985; Wilson 1997). The result is that its meaning also *becomes* fixed. There is no way of truly knowing the intentions of the original teller of the story, which could vary greatly between different individuals. Furthermore, some believe that the result of writing oral traditions is that the real human beings who inhabit those 'oral cultures' disappear, and stereotypes replace them (Bringhurst 1999).

Secondly, the interpreter must be aware of the inconsistencies of translation. Semantics are very important within oral histories and traditions. Translations to English usually are not exact, as not all words or concepts in native languages can be expressed in exactly the same way. In addition, Bringhurst (1999:19) states that "very literal, inch by inch translation – what scholars call a strict morphemic gloss ... can be wonderfully

revealing. (However), they also give a false sense of security and of scientific precision ... all translation seems to me at best (an) approximation". This is also an issue, albeit on a much smaller scale, between different native groups speaking different languages. Stories often were borrowed or adopted from other groups, making translations between local dialects necessary. Subtleties lost in such translation could have significant effects when interpreting aspects like context.

Furthermore, stories were also bought and otherwise exchanged among different groups. Therefore, for instance, a Tlingit story about earthquakes or glacial surges could end up being told among Haida or Tsimshian groups, which never had any direct interactions with those actual events. Distinguishing between stories with direct local relevance, and those that came from some distance can be difficult. Consequently, events depicted in oral traditions must be compared with the local geological record for relevance.

Another bias to consider is the notion of time and space. Natives and non-natives traditionally viewed time and space in very different ways, and this also must be taken into account when attempting to interpret oral traditions (Bielawski 1989:229). This also may affect how context (within an oral tradition) is viewed. For instance, the location of a site is often described in terms of landscape markers well known to those people, at that time, but perhaps not recognized today.

The extraction of clear-cut historical information, by a non-native from native oral traditions, can prove difficult and sometimes impossible. This is a result of the often complex multi-layered meanings and symbolism inherent within oral histories and oral traditions. In fact, oral traditions were not seen as vehicles for transmitting historical fact, but instead constituted mechanisms for confirming the very being and epistemology of the group(s) involved. This is discussed in greater detail later in this study. Nevertheless, the

greatest concern in this study is the historical information that survives within an oral tradition.

Literature Review

'Oral History Studies' consist of an immense body of theory and practice, which could be applied to the many collections of oral traditions spanning approximately the last 150 years documented in the Pacific Northwest. We are indebted to such prominent anthropologists and ethnographers as Franz Boas, James Teit, Charles Hill-Tout, Stith Thompson, Ella Clark, Lewis Spence and John Swanton (among others) for their collections of myths, legends, stories, cultural practices and oral traditions of First Nations groups in the Pacific Northwest. Globally, other regions also boast extensive recorded collections of rich oral traditions. Those oral histories have been extensively studied, as well as the archaeology and geology of these areas. Furthermore, the archaeology of geological catastrophes (McGuire et al. 2000) has been recently analyzed. However, the direct comparison of oral histories/traditions with archaeological/geological understandings of such past events still remains relatively scarce.

Until quite recently, very little work had involved integrating any oral traditions with archaeology and/or geology. Most notably, in the 1940's and 1950's, Frederica de Laguna made some connections between the oral traditions of Alaskan (Yakutat) groups and the archaeological and geological record, showing how certain traditions referred to specific earthquakes and flooding events (de Laguna 1972:1:286-291). In the 1980's, Stephen Harris (1976, 1985, 1990) related a few of the oral traditions of Washington and Oregon native groups to the eruption of Mount Mazama (and subsequent formation of Crater Lake), eruptions at Mount Rainer, the Three Sisters formation, and the

Bonneville/Cascade Landslide. Also, Julie Cruikshank (1981, 1992, 1998) made connections between the oral traditions of certain Yukon First Nations, and neoglacial Lake Alsek and Lowell glacier. Geologists Brian Atwater (1992,1995a, 1995b), John Clague (1982, 1994, 1995) and Ian Hutchinson (1997), as well as archaeologist Al McMillan (2002) have researched earthquakes and tsunamis along the Pacific Northwest Coast, and have made reference to the related oral traditions. Within the past 5 years, there has been an increase of such research, yielding several books, edited volumes and journal articles. This particular study follows the recent trend of linking oral traditions to geomorphological events. However, it examines the relationships between them in greater detail, attempting to understand the linkages in a more holistic manner. This is accomplished through the analysis of how different kinds of information get recorded into oral traditions, and how that information can change over time.

Indigenous Occupation

Establishing a time frame for the earliest human occupation and migrations into the Americas remains one of archaeology's most debated concerns. Regardless of which theory one believes, we can assume a human occupation everywhere in the Pacific Northwest at least throughout the Holocene, or the last 10000 years. The difficulty arises when trying to locate specific ethnographic groups prehistorically. The locations and configurations of First Nations groups at European contact undoubtedly are different from those at various times in the prehistoric past. The majority of these groups were seasonally highly mobile (much more so for interior groups), thereby making it difficult to pinpoint the past locations of specific tribes, despite the presence of sites with long histories of occupation (such as the 9000-10000 year sequences at Namu on the central

coast of British Columbia, and Ground Hog Bay on the Alaskan panhandle) (Carlson 1996:110). Although we cannot be certain whether these were the remains of ancestors of the ethnographic occupants, at least we know that somebody lived there that long ago. Specifically, sites in the modern territories of the Tlingit, Tsimshian, Haida, Nuxalk, Nish'ga, Gitksan, Kwakiutal, Nuu-chah-nulth, Makah, Coast Salish, Chinook, Tillamook, Klickitat, Wishram, Shasta, Klamath, Modoc and others (figure 2) have exhibited evidence of occupations extending back thousands of years, but with the ethnographic groups (or at least ethnographic styles of cultures) becoming clearly recognizable only sometime within the last 4000 to 5000 years. Intergroup trading was commonly practiced, which included goods, information and stories. Since stories often had an ownership associated to them, they were sometimes traded or given as gifts, as if they were valuable property. Moreover, given the close relationships (due to spatial proximity) of some of these groups, such as the Haida, Tlingit and Tsimshian, who exchanged goods and information (despite speaking totally different languages) over millennia, it can be difficult to determine the origin of some oral traditions. Contextually, if the historic location of a specific native group is close to some known catastrophic paleoenvironmental event that occurred in the prehistoric past, and that event is not recorded in their oral traditions, then that may suggest that they did not live in that area at that time.

All indigenous populations of the Pacific Northwest were drastically affected by the historic introduction of European diseases. Repeated outbreaks of smallpox, influenza, measles, dysentery, whooping cough, typhus and typhoid fever wiped out over 80% of the native population (some estimates are as high as 90%). Much, but not all of their culture (i.e. oral traditions, stories, legends, technological information, etc.) also died along with them. Of crucial importance to this study is the possible loss or lack of continuity of their oral traditions, which served as an epistemological vehicle for their culture.

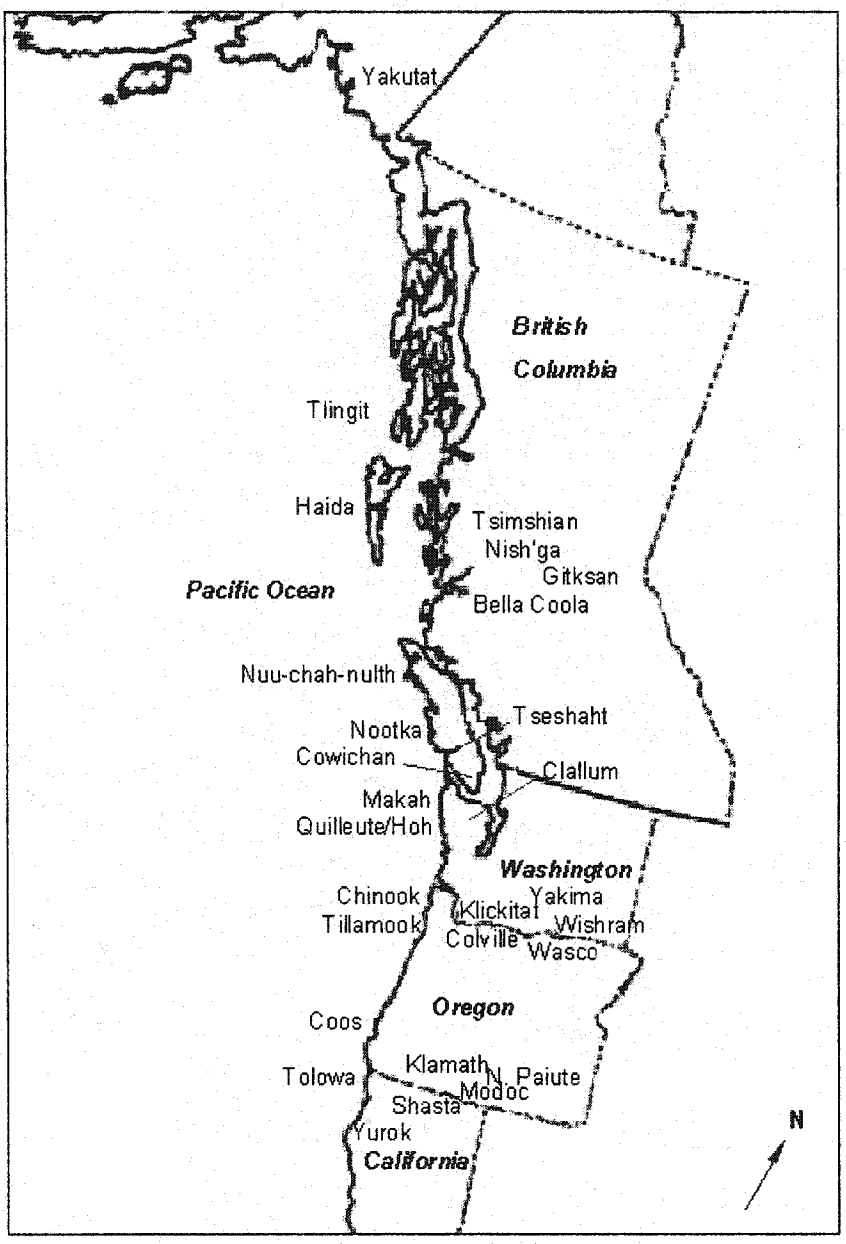


Figure 2: Map of the Study Area with Historic Locations of Relevant Native Groups

Oral Traditions

Before defining oral tradition, a discussion of the oral medium in general is appropriate. It essentially constitutes the manner in which information is communicated orally and probably has been important to First Nations societies for thousands of years.

Oral traditions, oral histories and narratives all were integral parts of their cultural life. In order to understand the extent and complexity of content and meaning within oral traditions, we must examine the overall position of 'orality' and 'narrative' within native individuals and society.

Oral Medium and Narrative

Julie Cruikshank (1990), an anthropologist at the University of British Columbia, shows how we may be able to see life stories and narrative as contributing to explanations of cultural process, rather than as simply aspects of ethnographic data. By examining three Yukon women as case studies, she shows how each of their life stories is a product of their cultural experience. Cruikshank (1990:2-20) found that these women use an oral tradition grounded in local idiom and a shared body of knowledge.

Angela Sidney was one of the Yukon women interviewed by Cruikshank. She stated that "...I've tried to live my life right, just like a story" (Cruikshank 1990:1), a statement which establishes the meaningful place that stories and narrative occupy in the lives of these women. Cruikshank (1990:29) further asserts that:

> (Sidney) reviews her early years with reference to the lives of others, commenting on her own experiences briefly and in the third person. She pays particular attention to recounting long and detailed narratives that were part of her education, implying that the lessons that they convey are self-evident. When she describes her years as a mature adult, though, she adds more of her own experience and then refers back to the traditional stories she has told earlier to explain specific points. By the end her own experience becomes the narrative line, reflecting her assertion that she has indeed tried to live her life "like a story".

Angela Sidney provides an interesting example of how storytelling permeates every aspect of native life. Her stories also address important questions about that life during a period of industrial and government expansion and social upheaval (Cruikshank 1990:339). Her account shows how she reflects on ideas from other cultures and adapts them for her own use, usually by relating them to other "old" stories that she knows.

Sydney was a trusted advisor, as she usually provided people with an appropriate narrative to broaden their framework for thinking about some question of concern to them (Cruikshank 1990:355).

Another good example of the importance of narrative is presented by Keith Basso (1996), who worked with the Western Apache. Basso systematically deconstructed the local idiom into three categories: 'ordinary talk', 'prayer', and 'narrative/stories'. Within the category of narrative story, he found four different types: myth, historical tale, saga, and gossip (Basso 1996:49). The significance of this work lies in the realization that only specific members of society can use certain types of narrative stories (also see Mills 1994:72-80). For example, among the Western Apache, myths deal with events that occurred 'in the beginning'. Myths are performed only by medicine men and women, and presented for the primary purpose of enlightenment and instruction (Basso 1996:49). By examining narrative within this culture, other cultural interactions and relationships can be understood. Thus, the ability to distinguish between such concepts as gossip and historical tale is vital in attempting to establish historical 'accuracy', as is done in this study.

Both Basso (1996) and Cruikshank (1990, 1998) show how stories and narrative are an integral component of the cultural constructions of First Nations peoples. Cruikshank (1998) states that "oral traditions show the capacity of humans to think symbolically about complex problems. Real life is full of contradictions. Narrative gives us ways to cope with a world riddled with contradiction". Equally important, both Basso and Cruikshank show how past and present components co-exist in life stories and narratives. This dual nature of storytelling is paramount in the definition of oral tradition.

For a formal definition of oral tradition, we may turn to Jan Vansina. In his classic work "Oral Tradition as History" (1961:19, 1985:27), he states that oral traditions are "verbal messages which are reported statements from the past beyond the present

generation". But not all sources of oral information are considered true oral traditions. Oral traditions must be transmitted for at least one generation (Vansina 1985:28).

Basically, oral tradition can refer to any unwritten body of material retained from the past, and known to the elders; as well as designate the process by which such material has been handed down to the present. Every society uses oral tradition, which is the oldest form of knowledge transmission and retention. An oral society's worldview is rich and complicated, and this is reflected in their oral tradition. Oral tradition must be understood in context; for example, the way of life, social organization such as moiety systems, potlatch traditions of giving and receiving, or the relationships with the land and animals (Ortiz 1998). Angela Cavender Wilson (1997:111), whose heritage is Dakota, provides a more holistic definition of oral tradition from a native perspective, while establishing a sense of the importance of oral tradition within native society:

> (oral traditions) provide moral guidelines by which one should live; they teach the young and remind the old what appropriate and inappropriate behavior consists of in our cultures; they provide a sense of identity and belonging; situating community members within their lineage and establishing their relationship to the rest of the natural world; ... (oral traditions) provide detailed descriptions about historical players – information such as our motivations, our kinds of decision making processes – as well as about how non-material , non-physical circumstances, or how those things belonging to the unseen spirit world have shaped our past and our understanding of the present ... the stories are considered by many native people to be living entities, with a power and spirit of their own.

Another important aspect of understanding oral tradition is that the information included may not be exclusive to the past. There is also present day information embedded within most oral traditions that must be recognized (Basso 1996; Cruikshank 1998; Ong 1982). Again, Vansina (1985:xii) states:

> Oral traditions are documents of the present, because they are told in the present. Yet, they also embody a message from the past, so they are expressions of the past at the same time. They are the representation of the past in the present. One cannot deny either the past or the present in them.

Thus, oral traditions always must be understood as reflecting both past and present simultaneously. Nevertheless, inherent in oral traditions are messages from the past, although we do not have continuous access to them. They only appear when they are told (or performed), persisting only in the memories of people. Members of oral societies do not doubt that those memories represent faithful repositories of the sum total of past human experience, and explain present day conditions (Vansina 1985:xi). It is the western intellectual community that conventionally has seen oral tradition as scientifically unsubstantiated, a problem that this study hopes to address.

Past and Present Components

This multifaceted nature of oral tradition can sometimes pose problems for researchers wishing to extract explicit and 'reliable' information about the past. One needs to determine the extent by which past components of oral traditions have been influenced by the present, or vice versa, in order to understand the intended meaning.

Walter Ong (1982:98), in his landmark work *Orality and Literacy: The Technologizing of the Word,* states that "in oral cultures the past is not felt as an itemized terrain, peppered with verifiable and disputed 'facts' or bits of information. It is the domain of the ancestors, a resonant source for renewing awareness of present existence, which itself is not an itemized terrain either". Therefore, since our current worldview has been formed by literacy, we need to remind ourselves that the past is conceived of differently in oral cultures (a reoccurring concept in this paper). Harry Robinson gives a good example of the past content of oral tradition being influenced by present day occurrences. He was a traditional Okanagan storyteller, whose stories serve as excellent examples of living oral traditions. In "Write it on your Heart" (Robinson 1989), Robinson's ability to incorporate current events in a meaningful way into his stories is clearly shown. The event in question

was Neil Armstrong's landing on the moon. Once this news had reached Robinson, he was not surprised at all. He claimed that white people were naïve. The author states that:

> He knew that Coyote's son had been there years ago...and that he (Armstrong) had simply followed the path that Coyote's son had learned about long ago, which is recorded in the old story, "Coyote Plays a Dirty Trick". In the story, Harry sees the earth orbit and the moon orbit of the Apollo mission as the two "stopping points" so critical to Coyote's son returning to earth. (Robinson 1989:22)

It seems evident that Robinson is viewing the past relative to the present. He uses old identifications to process the new information. Although this dual nature of oral tradition can be problematic for anthropologists, it can also provide valuable information about the person or cultural group in question. If different components can be separated, the extent to which the present has influenced the past may be determined, which may help in explaining other aspects of the society. Anthropologists must differentiate between the present and past influences before they can hope to understand the cultural infrastructure of a group.

Metaphors and Meaning

In very basic terms, the goal of anthropology is to study human nature, human society and the human past (Schultz and Lavenda 1995). Thus, to fully comprehend the lifeways of a group, past or present, one should make an effort to understand the epistemology of that group. A record of the richness of human nature and society, as well as epistemological issues, often exists within oral traditions. However, they can be difficult to elucidate. Before anthropologists can interpret oral traditions, they must first establish meaning. This is more involved than it sounds, as the anthropologist must decipher between *apparent* and *intended* meanings, which are often different.

In order to comprehend the intended meaning of an oral tradition, it is necessary to deal with issues of metaphor and symbolism (Basso 1996, Cruikshank 1998, Ong 1982,

Vansina 1985:86). Metaphor is a concept of principal importance in oral narratives of indigenous populations. For instance, to fully appreciate the relationships between individuals and the features of their landscape, the manner in which those relationships are conceptualized must be explored. Basso (1996:58) shows an excellent example of apparent and intended meaning with the use of metaphor. The following is a statement made by Nick Thompson, a Western Apache:

> This is what we know about our stories. They go to work on your mind and make you think about your life. Maybe you've not been acting right. Maybe you've been stingy. Maybe you've been chasing after women. Maybe you've been trying to act like a white man. People don't like it! So someone goes hunting for you – maybe your grandmother, your grandfather, your uncle. It doesn't matter. Anyone can do it.
>
> So someone stalks you and tells a story about what happened long ago. It doesn't matter if other people are around - you're going to know he's aiming that story at you. All of a sudden it hits you! It's like an arrow, they say. Sometimes it just bounces off – it's too soft and you don't think about anything. But when it's strong it goes in deep and starts working on your mind right away. No one says anything to you, only that story is all, but now you know that people have been watching you and talking about you. They don't like how you've been acting. So you have to think about your life.
>
> Then you feel weak, real weak, like you are sick. You don't want to eat or talk to anyone. That story is working on you now. You keep thinking about it. That story is changing you now, making you want to live right. That story is making you want to replace yourself. You think only of what you did that was wrong and you don't like it. So you want to live better. After a while, you don't like to think of what you did wrong. So you try to forget that story. You try to pull that arrow out. You think it won't hurt anymore because now you want to live right.
>
> It's hard to keep on living right. Many things jump up at you and block your way. But you won't forget that story. You're going to see the place where it happened, maybe everyday if it's nearby.....If you don't see it, you're going to hear it's name and see it in your mind. It doesn't matter if you get old – that place will keep on stalking you like the one who shot you with the story. Maybe that person will die. Even so, that place will keep on stalking you. It's like that person is still alive.
>
> Even if we go far away from here to some big city, places around here keep stalking us. If you live wrong, you will hear the names and see the places in your mind. They keep on stalking you, even if you go across oceans. The names of all these places are good. They make you remember how to live right.

This example, known as the 'hunting metaphor', acknowledges the power of oral narratives to "promote beneficial changes in people's attitudes toward their responsibilities as members of a moral community" (Basso 1996:57). It shows how oral narratives work

to achieve their intended meaning as expressed through the use of metaphor. If one wishes to interpret this narrative without the knowledge of the group's language and use of metaphor, the intended meaning would be almost impossible to retrieve. Native people who know the genre have little difficulty with determining intended meaning. Moreover, not all Western Apache people interpret the hunting metaphor for storytelling in the same manner. A successful metaphor is one that can be refined and elaborated in various distinct ways (Basso 1996, Cruikshank 1998, Hall 1997, Vansina 1985). The flexibility of the hunting metaphor does not diminish the intended meaning of the oral narrative, or the use of metaphor as an instrument of Western Apache epistemology (Basso 1996).

Group/Shared Accounts

Anthropologists and archaeologists also must recognize oral traditions that reference shared experience. The most typical oral traditions of many authors are 'group accounts'. They are the oral memories of various groups, such as villages, chiefdoms, kingdoms and kinship groups (Vansina 1985). Vansina (1985:19) states that oral traditions that reference shared experiences "embody something which expresses the identity of the group or substantiates rights over land, resources, women, office and herds. They are all institutionalized to some extent." Such oral traditions are voiced during formal events, such as potlatches, and considered the property of a group. Group accounts represent remarkable events that could not be allowed to be forgotten. Thus, the body of group accounts is constantly reshaped and separated into anecdotes, so that important meanings are emphasized and associations to other accounts are made clear (Cruikshank 1998, Vansina 1961, 1985). Therefore, given the intimate relationship between natives and their environment, it seems logical that catastrophic environmental events qualify as events 'that could not be allowed to be forgotten'.

There are numerous components of oral traditions that anthropologists and archaeologists must recognize before they may elucidate meaning. Only then can they determine cultural aspects such as epistemology, sexual roles, kinship, reciprocity practices, relationships with the land and animals, and technology (Ortiz 1998). Technology is an interesting concept for archaeologists to consider because it is often thought of as consisting just of tangible artifacts – such as 'sticks and stones'. However, some view technology as a primarily mental concept, embedded in narrative (Ingold 1993, Ridington 1998). Ridington (1999:171) states:

> Archaeologists must interpret physical objects in relation to an immaterial narrative technology that is not immediately available to their observation. They must practice what Whitney Davis calls an "archaeology of thought" bearing in mind that while "not all archaeological remains are remains of mental life, ... all mental life has remains" . Among contemporary hunter-gatherers, some of those remains are coded in the form of oral tradition and performance.

Therefore, concepts such as these are crucial in both archaeological and anthropological interpretation. Moreover, archaeologists may use oral traditions to help answer different sorts of questions, pertinent to their interests.

Archaeology and Paleoenvironmental Events

For the most part, archaeologists have concentrated on the interpretation of oral traditions that reference shared experiences. They often find that 'group accounts' may provide them with inferences about cultural behavior, such as migration routes, site locations, technological information, etc. Since archaeologists are more concerned with societal activities rather than those of single individuals, personal narratives are utilized less. However, they are crucial in initially understanding the deep structural organization of oral traditions.

There are literally thousands of examples of group accounts that may provide information useful to archaeology. One such example is a Tlingit oral tradition about Glacier Bay history. The story is about a young woman who is undergoing seclusion at

the onset of puberty (Swann 1994: 152). During her seclusion, she calls upon the glacier for companionship, which causes it to advance. In the end, the story teaches us that individual human action can have cosmic and social reactions. It also explains the mythical relationships among human, natural and spiritual realms (Swann 1994).

One of the main aspects of this oral tradition that archaeologists may find intriguing is the description of the ice flow and glacial movements. In this particular example, as told by Amy Marvin in 1984, the glacial movement was described as follows:

> At that time the ice didn't begin advancing from the top
> It began advancing from the bottom, from the bottom
> That was why no one knew
> All of a sudden it struck the middle of the land that people were living on
> Why was the land shaking?
> People thought it was an earthquake; it didn't bother anyone
> Then another one, then another one
> Why didn't it quit?
> Here it was the ice crushing against itself and moving in
> That was why they finally gathered together
>
> The house was already falling over on its side from how strong the ice was getting
> It was behaving like it was crushing against itself; [Slap!] how strong the ice was
> And they knew. It was the ice pushing the people wasn't it?
> It was pushing; it was pushing the village along
> This was when the people said, "Quick! Quick! Quick! Quick!"
> Let's move the people.
>
> (Swann 1994:157-159)

Such behavior is characteristic of glacial 'surges', or non-climatically driven advances in which a downstream 'bulge' of ice suddenly levels out. Furthermore, in Zuboff (1990:96), another account of Glacier Bay history is included. This particular example mentions the escaping of rapid glacial movements by going "under" the glacier:

> We would float down underneath the glacier
> in the boats.
> When we floated out from underneath,
> When nothing had happened to us we would stand
> In the boats
> And dance.

Thus, archaeologists wishing to understand the effects that ice advances had on the prehistoric peoples of the northern Northwest Coast could use such descriptions to substantiate or challenge existing theories of recent ice flow. Moreover, archaeologists may be able to shed light on possible migration routes. For instance, the possibility of a rapid glacial advance causing a migration, or rapid abandonment of a certain area, could be further researched. This oral tradition may also inspire the archaeologist to inquire about the plausibility of early people traveling "under" or "through" glaciers. Many present day sections of river valleys dammed by glaciers have internal channels or chutes, which might be suitable for migrating peoples for very short passages. (Clague 1999, Waters 1992).

From an archaeological perspective, the main goal of demonstrating commonalities between oral tradition and science would be to provide archaeologists with an alternate source of information about past cultures (i.e. oral traditions). If archaeologists can elucidate how specific paleoenvironmental events are represented in the oral tradition of a group, then perhaps they can use other oral traditions to document otherwise unknown events. For example, Christopher Hanks (1997) and Heather Harris (1997) argue that oral traditions collected from the Dene and Gitksan may preserve information about significant events that archaeological data suggest occurred nearly 10,000 years ago.

Hanks (1997) examines Dene views of the past and relates them to the archaeological and geological literature in an attempt to understand these two very different cultural perspectives. He notes that the natural events of the early Holocene and the oral traditions of the Dene show intriguing similarities. Hanks (1997:179) states that "The Yamoria cycle describes beaver ponds that filled the ancient basins of postglacial lakes, while other narratives appear to describe the White River ash fall of 1250 b.p.". He

concludes that archaeologists and the Dene must work in collaboration in order to appropriately reconstruct the past lifeways of the Dene.

Harris (1997) uses oral traditions of the Gitksan, along with archaeological and paleoenvironmental evidence, to reconstruct past origins and migrations. She also notes the strengths of both approaches, with archaeology better suited to show technological changes, whereas oral tradition may better describe "monumentous" events of the past (Harris 1997:194).

Such 'monumentous' or catastrophic environmental events, as emphasized in this study, may also be connected within a sequence. Often geological events are triggered or linked to one another (Clague 1995, 1999; Waters 1992), such as an earthquake or volcanic eruption causing a landslide, or a landslide causing a tsunami. This sequencing of events is apparent in the geological and archaeological record. For example, in 1964, a tsunami in Lituya Bay, Alaska was generated by a great earthquake, which triggered a landslide into the bay. It displaced a large mass of water, forming a tsunami that swept across the entire bay (approximately 2km). This particular sequencing of events is very exact, and if such sequencing presents itself in an oral tradition, one can be relatively certain that an actual past event of that type is represented.

Thus, the researcher must consider various issues and concepts before attempting to interpret oral histories or oral traditions from an archaeological (or geological) perspective. However, as formentioned, the greater the magnitude of the past event, the greater the likelihood it was recorded within the oral traditions of the local peoples. The detail regarding the event also is dependent upon its magnitude. Evaluating the historical content and accuracy of oral traditions for prehistoric times presents challenges. Again, the use of oral traditions to interpret historical events is not a new approach, but one that is not as developed in its methods as some kinds of historical research (Mason 2000; Vansina 1985:3-32). Linking the historical aspects of oral tradition to independent

collaborating evidence (such as geological and archaeological data) is one means of affirming historical 'accuracy' within a western scientific perspective. The following three case studies are all catastrophic paleoenvironmental events of great magnitude that appear to have been recorded within First Nations oral traditions.

The Eruption of Mount Mazama: 6850 b.p.

Indigenous groups living in volcanic areas, who must cope with the resulting awesome displays, have often attributed them to the supernatural (i.e. beings, deities, demons, etc.). The Mayans, Incas and Aztecs offered human sacrifices to volcanoes (Grayson and Sheets 1979). More recently, the Javanese sacrificed humans to Mount Borneo (Vitaliano 1973). Historically, in Nicaragua, a baby was thrown into a crater every twenty-five years to maintain its tranquility. Presently, in some areas animals are still sacrificed to volcanoes in hopes that their destructive forces will ease, or remain peaceful. If any of these offerings failed to prevent an eruption, it was believed that "things might have been worse without them" (Vitaliano 1973:104).

Myths, legends, oral traditions and ancient written accounts about volcanoes and eruptions come in different forms. They may attempt to account for the presence of individual volcanoes or related landforms. As well, they may try to explain volcanic activity in general, or specific individual eruptions (Vitaliano 1973). In the Pacific Northwest, an eruption of great magnitude occurred in 6850 b.p., when Mount Mazama catastrophically exploded in south central Oregon, culminating a long sequence of earlier smaller scale eruptions. Geologically, that eruption is well known and dated, and has been extensively studied. However, indigenous native populations at the time of the eruption were nomadic and lacked a written language. Globally, there have only been three other eruptions within the last 10,000 years that had the same magnitude as Mt. Mazama (Simkin et al.

1981). Eruptions of such magnitude also may have a profound effect on the surrounding environment.

Analysis of Catastrophe

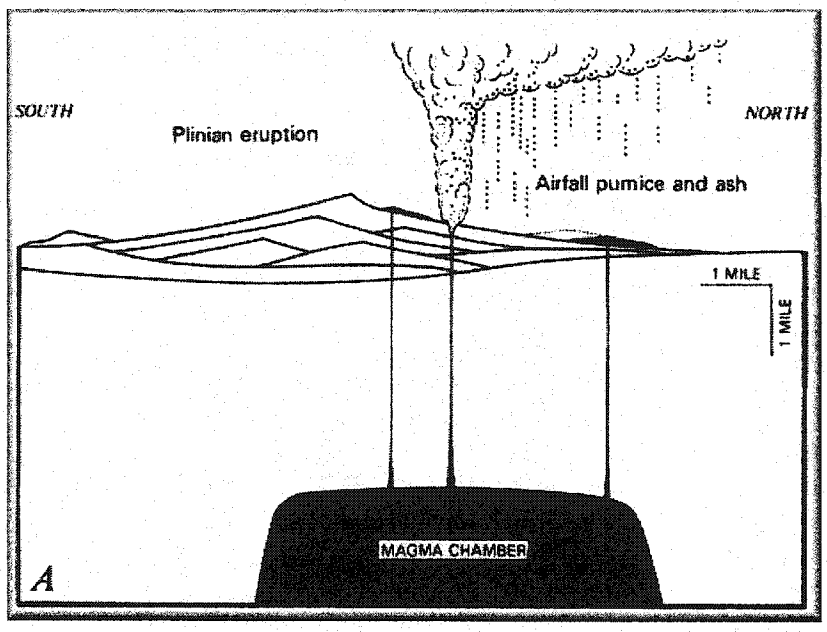
Geologically speaking, Crater Lake is a type of volcanic depression called a caldera (from Spanish for "cauldron"), formed by the collapse of the estimated 3,700m high Mount Mazama during that enormous eruption approximately 6850 b.p. (Fisher et al. 1997:46). That climactic eruption of Mount Mazama followed a series of smaller events and significantly altered the immediate surrounding landscape. Pyroclastic flows devastated the surrounding area, including all of the river valleys that drained Mount Mazama to as far as 64 km away. The ashfall extended northeast of the volcano as far as Saskatchewan, Canada. Pumice and ash covered a total surface area of more than 2,600,000 km^2 at least 1 mm thick, and no less than 13,000 km^2 more than 15 cm thick (Williams and Goles 1968; U.S.G.S 2001: see internet resources). Rare particles of Mazama ash even have been found in ancient ice as far away as Greenland. Moreover, the ejected pumice and ash probably reached more than 30 kilometres high above Mount Mazama (Harris 1990:219). It is estimated that this cataclysmic eruption was at least 40 times greater than the A.D.1980 eruption of Mt. St. Helens.

As the Mazama eruption continued it also increased in magnitude, producing massive, fast moving flows of hot ash and pyroclastic material. The magma chamber deep below the mountain increasingly ejected its contents. As the enormous volume of magma (54-63 km^3) was rapidly removed to feed the eruption, the mountain's underlying support weakened, and the roof of the magma chamber (upper portion of the mountain) collapsed, forming a dish shaped depression known as a caldera (Bacon 1983; Williams and Goles 1968). The caldera has a diameter of approximately 10 km east to west and 8 km north to south, with an approximate average depth of 1,200 m from rim to lake floor (Nelson et al,

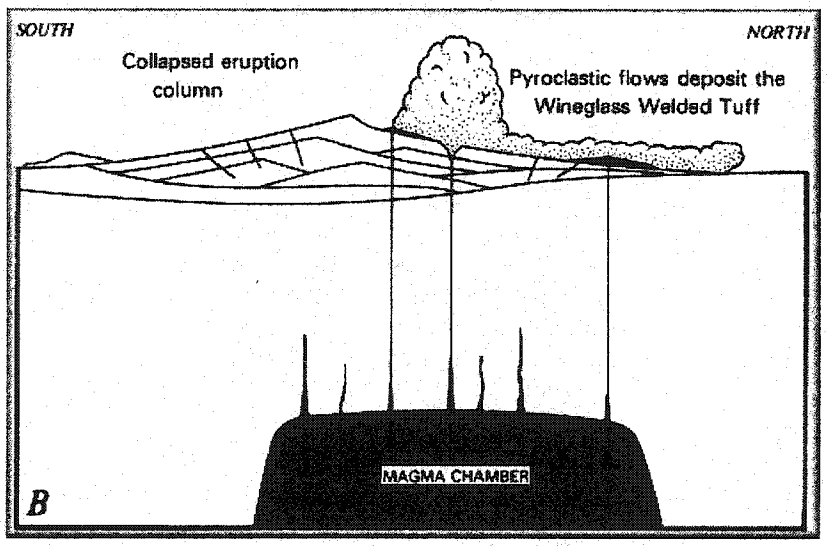
1994). Geologists estimate that the entire event could have lasted from a few days to over a month.

Prior to the climactic eruption, Mount Mazama had a 400,000 year history of lesser activity similar to other Cascade volcanic centers, such as Mount Shasta. In general, the only activity in the 30,000 years, prior to that caldera-forming climactic eruption of 6850 b.p., was limited to a small number of smaller pyroclastic eruptions and subsequent lava flows. Since the climactic eruption, there have been a few insignificant eruptions, all situated within the caldera, including the formation of a small rhyodacite dome about 5,000 years ago (Nelson et al. 1994). These eruptions have helped to seal the caldera's bottom. Over hundreds of years, heavy annual snow and rainfalls filled the caldera, eventually creating a lake with a depth of nearly 800 metres. Today, the lake is in a state of equilibrium, neither significantly increasing nor decreasing its levels. Its stability results from a balance between an outflow of seepage and evaporation, and any incoming precipitation.

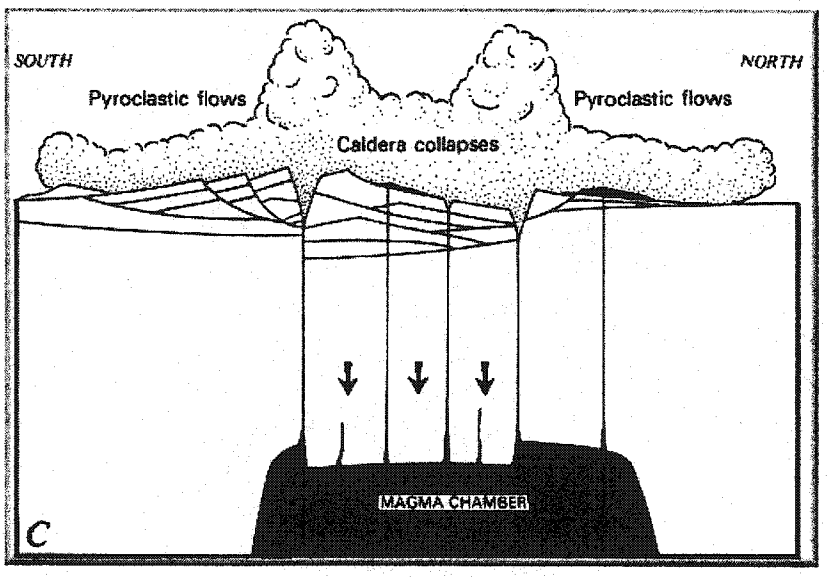
Studies show that hydrothermal activities are present at the lake floor and that water is heated by hot rock beneath the fractured caldera floor (Matz 1991; Nelson et al. 1994). Scientists are not certain whether any magma still remains underground. However, it is likely that Mount Mazama may erupt again someday.



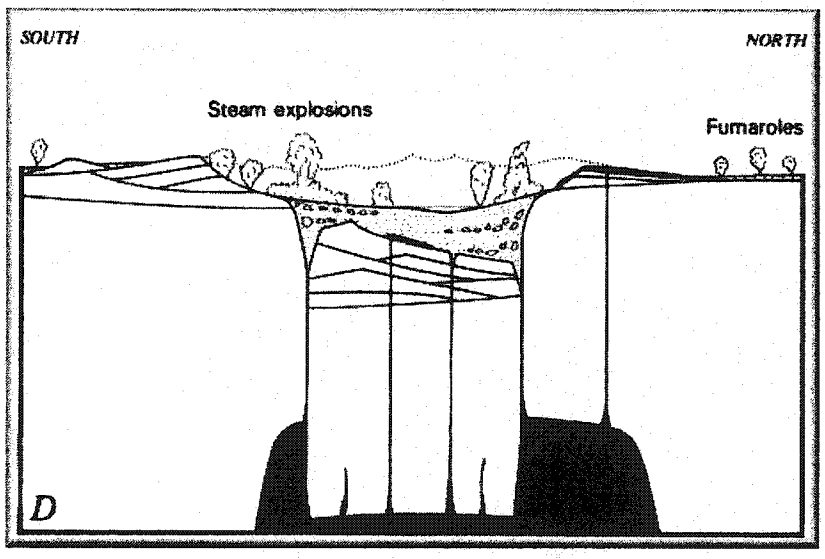
A: Plinian eruption ejects pumice and ash from a single vent, which is carried hundreds of kilometres northeast by blowing winds



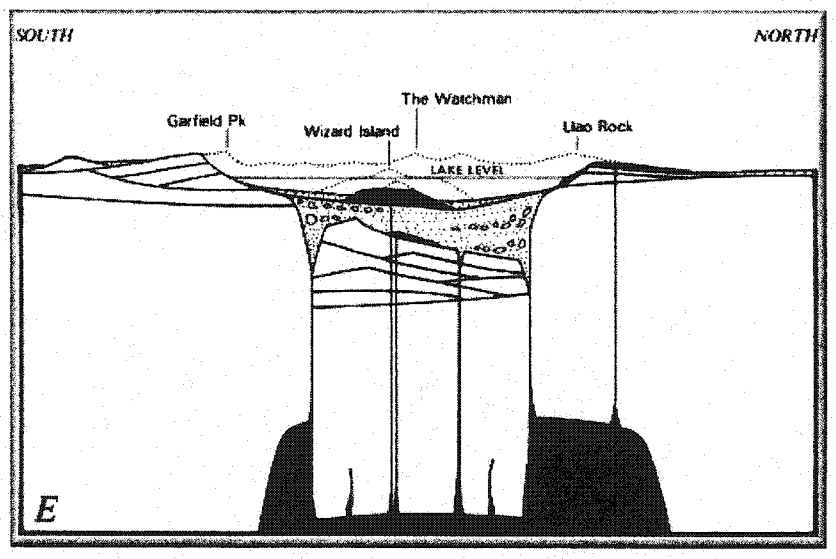
B: Vent enlarges, erupted volcanic material forces the column to collapse, triggering the first major pyroclastic flow



C: As the underground magma chamber is drained, Mount Mazama's former summit collapses, forming a caldera. New vents open above fractures and pyroclastic flows deposit pumice and ash on all flanks and valleys of Mount Mazama.



D: Steam explosions deposit large amounts of pumice and ash, partially filling the caldera.



E: Today – Wizard Island and other submerged cones on the caldera floor were built by post-caldera eruptions. Snow melt and rain have filled the basin approximately half way, forming Crater Lake.

Figure 3: Geomorphological Processes (A-E) Involved in the Eruption of Mt. Mazama (Taken from Harris 1990:216-218 and the U.S. Geological Survey, August 2001)

The Mazama eruption was of Plinian type – i.e. extremely explosive eruptions that exhibit sustained jetting of volcanic ash into a high cloud (Decker and Decker 1991:12). To put eruption events in perspective, geologists have developed a magnitude eruption scale – called the Volcanic Explosivity Index (VEI) (Blong 1984). This index is based on various properties of volcanic eruptions, such as plume height, volume and frequency. The following chart illustrates the reconstructed magnitude of the Mt. Mazama eruption in a global-historical context.

VEI	Description	Plume Height	Volume	Frequency	Example
0	non-explosive	<100 m	1000s m3	daily	Kilauea
1	gentle	100-1000 m	10,000s m3	daily	Stromboli
2	explosive	1-5 km	1,000,000s m3	weekly	Galeras, 1992
3	severe	3-15 km	10,000,000s m3	yearly	Ruiz, 1985
4	cataclysmic	10-25 km	100,000,000s m3	10's of yrs	Galunggung, 1982
5	paroxysmal	>25 km	1 km3	100's of yrs	St. Helens, 1981
6	colossal	>25 km	10s km3	100's of yrs	Krakatau, 1883
7	super-colossal	>25 km	100s km3	1000's of yrs	Tambora, 1815 Mazama, 6850 b.p.
8	mega-colossal	>25 km	1,000s km3	10,000's of yrs	Yellowstone, 2 Ma

Table 1: Description of the Volcanic Explosivity Index (VEI)
(Simkin et al., 1981)

Only four eruptions in the last 10,000 years have been assigned a 'supercolossal' VEI of 7. They are: Tambora, Indonesia A.D. 1815; Baitoushan, China-Korea border, about A.D. 1050; Kikai, Japan, about 6300 b.p.; and Mt. Mazama/Crater Lake, Oregon, USA, about 6850 b.p.

Related Geologic Activity

Consideration also should be given to possible influences of other nearby volcanic activity on native oral traditions. Other, similar (but smaller scale) local eruptions may complicate determining which oral tradition refers to which event. Crater Lake is in a region with several other volcanoes that also have erupted during the Holocene. From

north to south, they are: Mt. Rainier, Mt. St. Helens, and Mt. Adams in Washington, Mt. Hood, Mt. Jefferson, Three Sisters and the Newberry Caldera in Oregon, and Mt. Shasta in California. They have all had significant eruptive episodes within the past 10,000 years. However, only two eruptions formed a 'caldera': Mt. Mazama and the Newberry volcano.

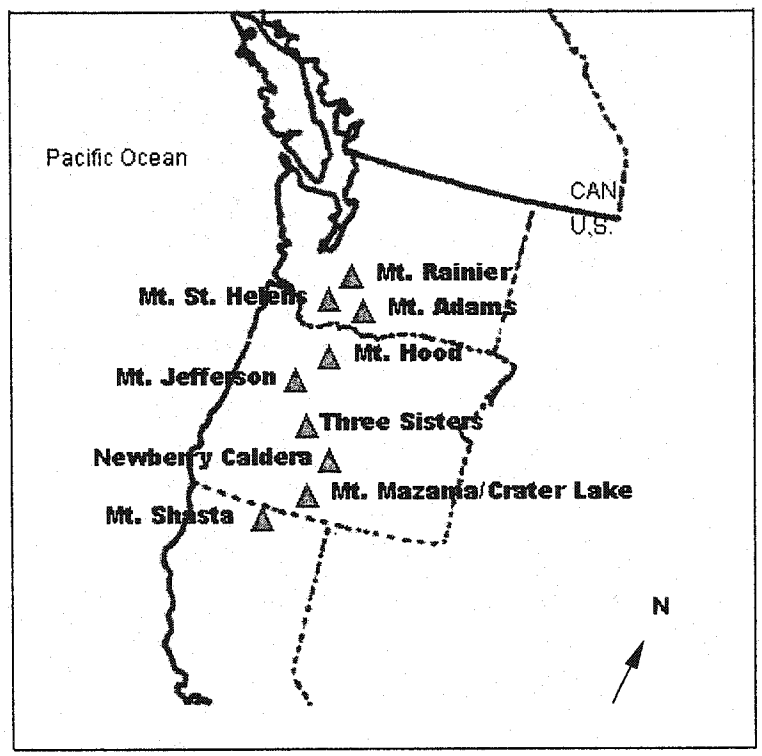


Figure 4: Volcanoes with Eruptive Histories Situated Near Mt. Mazama

The Newberry caldera, located just northeast of Crater Lake, also has been built by thousands of eruptions, beginning about 600,000 years ago. Approximately 25 vents on the flanks and summit have been active during several eruptive episodes in the past 10,000 years. Most recently, an eruption 1,300 years ago produced what is commonly referred to as the 'Big Obsidian Flow' (McKee 1972; Sherrod et al. 1997). There has been frequent volcanic activity within the caldera during the past 10,000 years. Other eruptions

during this time have occurred along a rift zone on the volcano's northwest and south flanks.

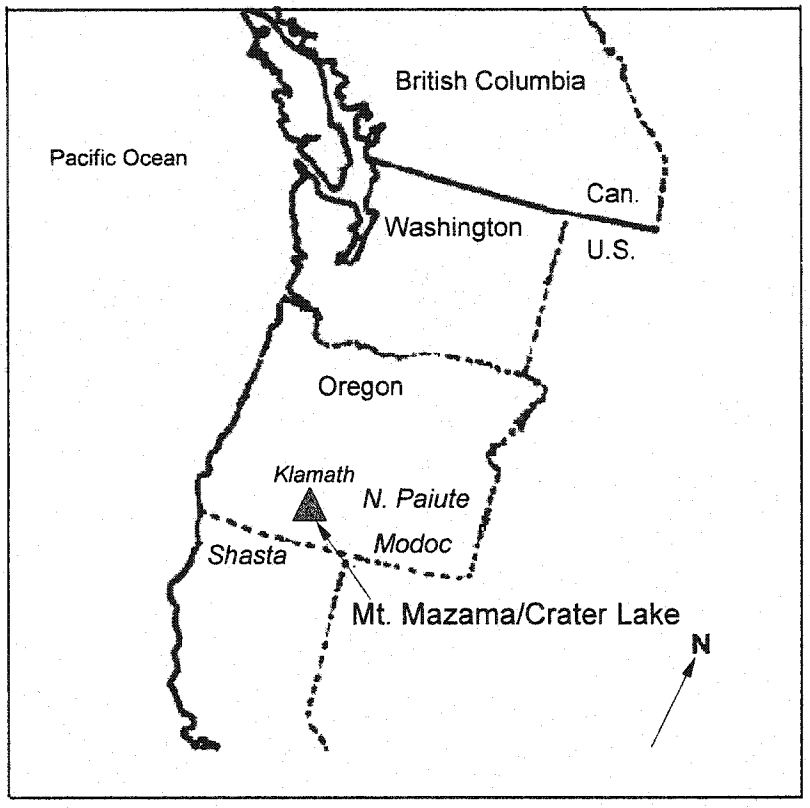


Figure 5: Location of Mt. Mazama/Crater Lake and Local Native Groups

Native Inhabitants

Historically, predominant native groups occupying the immediate area around Crater Lake are the Klamath, Modoc and Northern Paiute (Howe 1968; Stern 1965). However, as stated previously, it cannot be demonstrated that they were in that area during the time of that eruption. The archaeological record shows that humans did exist in that area at the time of the eruption, but specific ethnolinguistic identification is not possible.

Archaeology

There have been scattered archaeological finds in central and south central Oregon that indicate the presence of humans in that area prior to the Mt. Mazama climactic eruption. For instance, a nearby cave in Fort Rock Valley yielded a long sequence of occupations perhaps going back as far as 13,000 years. Typically, in the interior Pacific Northwest, archaeological characteristics during the time of the Mazama eruption include: small site sizes and relatively infrequent numbers of sites, low assemblage diversity, fluted point types (in the interior of the U.S. northwestern sites) and lithic raw materials derived from distant sources. Together, these attributes depict a pattern of short-term, non-recurrent use of particular sites and areas (Howe1968).

Between 7,000 b.p. and 2,000 b.p., during a period known as the Middle Archaic, there is a substantial increase in evidence for a human presence in Central Oregon. During this time, inter-regional trade networks became more firmly established, with trade goods helping to offset periodic, localized shortages of food and other commodities (Jennings 1986). Habitations consisted primarily of clusters of pithouse dwellings, indicating the beginning of a cultural pattern that persisted locally until the time of European contact, although few sites have been discovered in comparison to later periods. Sites also were small, but some favored locations were visited many times, and substantial deposits built up. One very early site is the Stockhoff basalt quarry near La Grande, was first used approximately 10,000 years ago and then continually until European contact. It grew to be perhaps the largest site in Oregon, at over 4,000 acres (Cressman 1977) Some areas of the site are estimated to be nearly 4 metres deep, containing artifacts covered by primary Mazama ash. Evidence indicates that people likely ceased their activities when the eruption occurred, which would have covered the skies with thick, dark clouds of ash. An artist's rendition of what Mazama may have

looked like during the time of the eruption is seen in figure 6, and figure 7 shows the profile of that mountain reconstructed against the modern horizon.

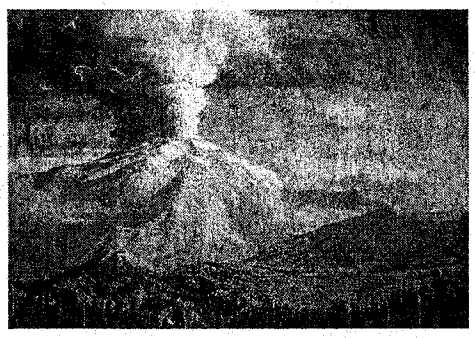


Figure 6: Mazama Before Eruption. Painting by Paul Rockwood
(Rockwood 1998: see internet resources)

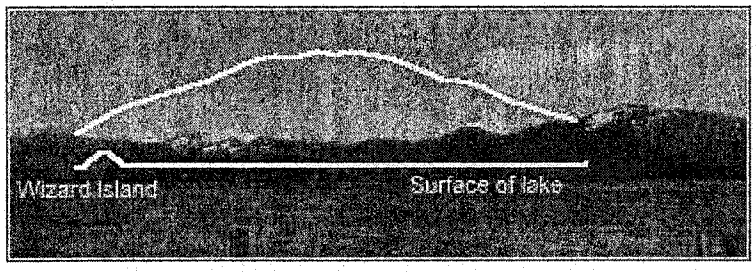


Figure 7: Mazama, as seen today, and Before the Climactic Eruption
(U.S.G.S. June 2001: see internet resources)

Oral Traditions

When dealing with an event of such antiquity, the likelihood of encountering oral traditions clearly related to it would seem low. A search of recorded Modoc and Paiute oral traditions failed to produce stories of the destruction of Mt. Mazama and consequent formation of Crater Lake. Remarkably, however, the Klamath have one story that appears to describe that event in some detail. This particular story was told by Chief Lalek, Peace

Chief of the Klamath Indians, in 1865. He was asked why the Native Americans never visit Crater Lake or look down upon its waters.

A long time ago, so long that you cannot count it, the white man ran wild in the woods and my people lived in rock-built houses. In that time, long ago, before the stars fell, the spirits of the earth and the sky, the spirits of the sea and the mountains often came and talked with my people.

Sometimes the Chief of the Below World came up from his home inside the earth and stood on the top of the mountain - the high mountain that used to be. At that time there was no lake up there. Instead, there was an opening which led to the lower world. Through it the Chief of the Below World passed from his home to the outside world and back again.

When he came up from his lodge below, his tall form towered above the snow-capped peaks. His head touched the stars around the lodge of the Chief of the Above World, the all-powerful chief.

One time when the Chief of the Below World was on the earth, he saw Loha, the daughter of the tribal chief. Loha was a beautiful maiden, tall and straight as the arrowwood. Her eyes were dark and piercing; her hair was long and black and glossy. She was beloved by all her father's people, and warrior chiefs from many nations had tried to win her favor.

The Chief of the Below World saw her and fell in love with her. He told her of his love and asked her to return with him to his lodge inside the mountain. There, he said, she would live forever and forever. But Loha refused to go with him.

Then the Chief of the Below World sent one of his warriors to a feast of the tribe, to plead for him and to arrange for a marriage with Loha.

"The maiden shall have eternal life," promised the warrior. "She shall never know sickness or sorrow or death when she becomes the mate of the Chief of the Below World. The great chief demands that she come with me."

But again the maiden refused. And the wise men of the council would not command her to go. Instead, they advised her to hide herself from the sight of the Chief of the Below World.

When the messenger returned to the middle of the mountain and reported the maiden's answer, the Chief of the Below World was very angry. In a voice like thunder, he swore that he would have revenge on the people of Loha, that he would destroy them with the Curse of Fire. Raging and thundering, he rushed up through the opening and stood upon the top of his mountain.

Then he saw the face of the Chief of the Above World shining among the stars that surround his home. Slowly the mighty form of that chief descended from the sky and stood on the top of Mount Shasta. From their mountaintops the two spirit

chiefs began a furious battle. In a short time all the spirits of earth and sky took part in the battle.

Mountains shook and crumbled. Red-hot rocks as large as the hills hurtled through the skies. Burning ashes fell like rain. The Chief of the Below World spewed fire from his mouth. Like an ocean of flame it devoured the forests on the mountains and in the valleys. On and on the Curse of fire swept until it reached the homes of the people. Fleeing in terror before it, the people found refuge in the waters of Klamath Lake. Mothers stood there holding their babies in their arms and praying that the awful war might end. Men prayed to the Chief of the Above World to save them from destruction by the Curse of Fire.

Two great medicine men lifted up their voices. "Our people have done wrong," said one of them. "Because of our wickedness, the Curse of Fire has been sent upon us. Only a living sacrifice will turn away the wrath of the Chief of the Below World, who has sent the Curse of Fire. Who among us will offer himself as a living sacrifice?"

"No young man will want to make the sacrifice," answered the second of the great medicine men. "We old men have but a few more suns to live. We should be the ones to throw our torches into the fiery pit of the Chief of the Below World. We should be the ones to follow our torches into the fire. Then will the sins of our people be forgiven."

The Chief of the Above World heard the voices of the medicine men and spoke to the people from the top of Mount Shasta. "Your wise men have spoken the truth. You have not listened to my voice, though I have spoken - again and again. Now you are being punished. Your land is being laid waste."

As his voice ceased, the two medicine men, the oldest and most revered of the Klamath people, rose from the water, lighted their pine torches, and started toward the mountain of the Chief of the Below World. From the waters of Klamath Lake the people watched the flare of the torches move up the long ridge on the east side of the mountain. Brilliant against the night sky, the torches moved on to the top of the cliff which hung over the entrance to the Below World.

On that cliff stood the angry Chief of the Below World. There the medicine men paused for a moment, watching the flames and smoke coming up through the opening. Then they lifted their burning torches high above their heads and jumped into the fiery pit.

The great Sahale Tyee, the Chief of the Above World, standing on Mount Shasta, saw the brave deed of the medicine men. He saw that it was good. Once more the mountains shook. Once more the earth trembled on its foundations. This time the Chief of the Below World was driven into his home, and the top of the mountain fell upon him. When the morning sun rose, the high mountain was gone. The mountain which the Chief of the Below World had called his own no longer towered near Mount Shasta.

Then rain fell. For many years, rain fell in torrents and filled the great hole that was made when the mountain fell upon the Chief of the Below World. The Curse of Fire was lifted. Peace and quiet covered the earth. Never again did the Chief of the Below World come up from his home. Never again did his voice frighten the people.

Now you understand why my people never visit the lake. Down through the ages we have heard this story. From father to son has come the warning, "Look not upon the place. Look not upon the place, for it means death or everlasting sorrow."

The Oral Tradition of "The Origin of Crater Lake"

The above oral tradition was first recorded in the autumn of 1865 by William M. Colvig, a young soldier stationed at Fort Klamath near Crater Lake. Ella Clark first published this account in 1953, from Colvig's personal manuscripts. Again, this story was told by Chief Lalek, the apparent 'Peace Chief' of the Klamath Indians (Clark 1953:53-55).

Comparative Analysis

In order to better illustrate any correlations that may exist between the Klamath account and the geological and archaeological evidence related to the Mt. Mazama climactic eruption, the following qualitative table has been created. Exact passages from the native account are presented in the first column, and matched to apparently appropriate scientific evidence in the second column.

	Native Oral Account	**Geological/Archaeological Evidence**
Pre-Event	A long time ago, so long that you cannot count it, the white man ran wild in the woods and my people lived in rock-built houses	Evidence of human occupation in caves and rock-shelter dwellings prior to the Mt. Mazama eruption 6850 b.p. (Howe 1968:25)

Sometimes the Chief of the Below World came up from his home inside the earth and stood on the top of the mountain - the high mountain that used to be. At that time there was no lake up there. Instead, there was an opening which led to the lower world. Through it the Chief of the Below World passed from his home to the outside world and back again.	It is estimated that Mt. Mazama was approximately 3,700 metres in elevation. There were no significant bodies of water on Mt. Mazama. The only activity within the 30,000 years prior to the 6850 b.p. eruption was a small number of preclimactic pyroclastic eruptions and resultant lava flows.
When he came up from his lodge below, his tall form towered above the snow-capped peaks. His head touched the stars around the lodge of the Chief of the Above World, the all-powerful chief.	The eruption began with a massive expulsion of pyroclastic materials mostly consisting of pumice and fine ash. It covered an immense area (2.6 million km^2) and traveled as far as Saskatchewan, Canada (David 1970). It is estimated that this stage of the eruption could have lasted a few days.
In a voice like thunder, he swore that he would have revenge on the people of Loha, that he would destroy them with the Curse of Fire. Raging and thundering, he rushed up through the opening and stood upon the top of his mountain.	The second stage of the eruption consisted of a 'boiling over' of magma from the interior of Mt. Mazama. Therefore, this expulsion was not as high or vertical as the preceding pumice/ash phase. Moreover, given the moisture present due to the ash cloud, thunder and lightning may have been present.
Slowly the mighty form of that chief descended from the sky and stood on the top of Mount Shasta. From their mountaintops the two spirit chiefs began a furious battle. In a short time all the spirits of earth and sky took part in the battle.	Mt. Shasta is 4317 metres high and dominates the southern Oregon and northern California skyline. It has erupted at least every 600 to 800 years during the Holocene, with the most recent eruption occurring in 1786. (U.S.G.S. August 2000: see internet resources).
Mountains shook and crumbled. Red-hot rocks as large as the hills hurtled through the skies. Burning ashes fell like rain. The Chief of the Below World spewed fire from his mouth. Like an ocean of flame it devoured the forests on the mountains and in the valleys. On and on the Curse of fire swept until it reached the homes of the people.	The catastrophic eruption undoubtedly would have shaken the immediate area. Ash fall within the local area is estimated at 20 cm thick (surely thicker than that closer to the mountain. Pyroclastic lava covered nearly all of the flanks of the volcano and flowed into the surrounding valleys. The homes of the people were likely situated near Klamath Lake.

During Event

	Fleeing in terror before it, the people found refuge in the waters of Klamath Lake.	Klamath Lake is the closest logical place of refuge to escape a lava flow from Mt. Mazama.
During Event	The Chief of the Above World heard the voices of the medicine men and spoke to the people from the top of Mount Shasta. "Your wise men have spoken the truth. You have not listened to my voice, though I have spoken - again and again. Now you are being punished. Your land is being laid waste."	Implies knowledge of previous eruptions of Mt. Shasta, which, indeed, have been frequent throughout the Holocene (at least once every 600-800 years). Most of the land flanking Mt. Mazama was covered with pyroclastic flows, lava and ash.
	Once more the mountains shook. Once more the earth trembled on its foundations. This time the Chief of the Below World was driven into his home, and the top of the mountain fell upon him. When the morning sun rose, the high mountain was gone. The mountain which the Chief of the Below World had called his own no longer towered near Mount Shasta	After the large quantities of pyroclastic material were removed, a void was created. Therefore, support for the volcanic cone was removed and the mountain collapsed upon itself, forming an enormous, circular caldera.
Post-Event	Then rain fell. For many years, rain fell in torrents and filled the great hole that was made when the mountain fell upon the Chief of the Below World. The Curse of Fire was lifted. Peace and quiet covered the earth. Never again did the Chief of the Below World come up from his home. Never again did his voice frighten the people.	It would have taken approximately 250-500 years to fill the crater with rainwater similar to present day levels. There has not been another eruption of any significance since the eruption in 6850 b.p.
Post-Event Adaptation	Now you understand why my people never visit the lake. Down through the ages we have heard this story. From father to son has come the warning, "Look not upon the place. Look not upon the place, for it means death or everlasting sorrow."	Very little pre-contact archaeological evidence has been found at Crater Lake. A few arrow points and evidence of small ceremonial offerings have been found. However, this evidence has been attributed to hunting expeditions and not habitation sites (Brown 1952; Smith 1934)

Table 2: Descriptive Comparison of Geological Evidence and Oral Tradition

Discussion

At first glance, there seems a deep, metaphoric meaning inherent in this oral tradition. Llao's intense passion for Loha is nearly identical to the classic Greek mythological tale, where Hades (God of the underworld) pursued a reluctant maid Persephone, and carried her off to his subterranean kingdom (Harris 1990:218). Thus, this metaphor is likely a widespread concept, common in human epistemologies. Additionally, there appear to exist several similarities between the geologic account of the eruption of Mt. Mazama and the Klamath oral tradition.

Archaeological evidence has shown that local habitation sites during the time of the eruption consisted of mainly pithouse dwellings, but rock shelters and cave dwellings also have been found (Howe 1968). Moreover, Mount Mazama, before the 6850 b.p. eruption, was volcanically active, and lacked a lake of any significance. Thus, the oral tradition appears to have recorded information similar to the geological account regarding the environmental setting before the eruption took place, where it is mentioned that people lived in rock built houses, the "high mountain that it used to be" did not possess a lake, and the "Chief of the Below World" often passed through an opening in the top of the mountain – which may be interpreted as frequent volcanic activity. There is no mention of the floral and faunal environment prior to the eruption.

The eruptive history of Mount Mazama (summarized in the 'Analysis of Catastrophe' section of this paper) has been the subject of extensive research (Bacon 1983; Harris 1976, 1985b, 1990, 2000; Homuth 1928, 1929, 1930; Libby 1931; Mark and Mastroguiseppe 1995; Matz 1991, McDonough 1996; Nelson et al. 1994; Smith 1934; Winthorp 1997; and others). Geologically, we are certain that the climactic eruption of Mt. Mazama, and subsequent formation of Crater Lake, included three distinct stages. The first consisted of the expulsion of pumice and ash more than 30 kilometres high into the

stratosphere. The second stage consisted of the emptying of the enormous magma chamber located deep within the mountain itself. As a result, the upper portion lost its underlying support, and collapsed upon itself (third stage).

The interpretation of the Klamath oral tradition appears to yield the three stages as well. The first stage is referenced as "When he came up from his lodge below, his tall form towered above the snow-capped peaks. His head touched the stars...In a voice like thunder...he would destroy them with the Curse of Fire...raging and thundering, he rushed up through the opening and stood upon the top of his mountain.". This description implies that a 'tall' form came out from within the mountain and 'stood' on top of the mountain. This particular form was not referred to as 'fiery', as a clear distinction is made between the 'form' and his weapon of destruction, the 'Curse of Fire'. Moreover, the impression of 'standing' on top of the mountain before the 'Curse of Fire' was dealt could imply that there was a pause in the eruption sequence, or that the cloud of ash persisted for some length of time. Volcanic eruptions are commonly described in oral traditions, myths, stories etc, as erupting fire and power immediately (Harris 2000). The standing of a 'non-fire' like figure high upon the top of a mountain for a period of time may be interpreted as a massive ash and pumice cloud that preceded the actual magma (fire) event.

The second stage is described in the oral tradition as:

> Then he saw the face of the Chief of the Above World shining among the stars that surround his home. Slowly the mighty form of that chief descended from the sky and stood on the top of Mount Shasta. From their mountaintops the two spirit chiefs began a furious battle. In a short time all the spirits of earth and sky took part in the battle. Mountains shook and crumbled. Red-hot rocks as large as the hills hurtled through the skies. Burning ashes fell like rain. The Chief of the Below World spewed fire from his mouth. Like an ocean of flame it devoured the forests on the mountains and in the valleys. On and on the Curse of fire swept until it reached the homes of the people. Fleeing in terror before it, the people found refuge in the waters of Klamath Lake. (Clark 1953:53)

Thus, a battle appears to have taken place between Mt. Mazama and Mt. Shasta. A typical description of volcanic eruptions is included: "mountains shook and crumbled, and red rocks thrown across the skies". The "ocean of flame" represents the magma discharge and its flow down the mountain slopes initiating forest fires. However, the tradition also mentions that other spirits of the earth and sky participated. Perhaps this is reference to thunder, lightning and heavy rainfall, all of which were likely present after the initial ash cloud, due to the entrapment of moisture by the ash cloud (McDonough 1996), causing panic in both animals and humans. Furthermore, during the Mt. St. Helens eruption in A.D. 1980, in two months surrounding the event, approximately 10,000 earthquakes were recorded directly beneath the volcano (Mullineaux 1986; Hoblitt et al. 1980). Thus, there is reason to believe that thunder, lightning, rain and earthquakes were present during the Mazama eruption, which may correlate to the statement "all the spirits of the earth and sky took part in the battle".

The third stage consists of the magma chamber and upper portion of the mountain collapsing upon itself and forming a caldera. This was due to loss of the underlying structure, as enormous volumes of magma were expulsed. The formation of a caldera is considered rare, even on a global scale. Yet the Klamath account clearly states that "the Chief of the Below World was driven into his home, and the top of the mountain fell upon him."

Other correlations that exist between geological reconstructions and the Klamath oral tradition of the Mazama eruption include people seeking refuge in Klamath Lake, the filling of the lake with rainwater, and the tranquility of the mountain since the 6850 b.p. eruption. The pyroclastic flow was estimated to have traveled approximately 64 km down slope into the valleys below Mt. Mazama, ending near the center of Klamath Lake. Thus, the remainder of that lake would have been the first place of refuge for the people fleeing that eruption. Second, it would have taken hundreds of years of rain and snowfall to fill

the newly formed crater. This too is referenced in the oral tradition, where it is stated, "for many years...the rain fell...and filled the great hole". Lastly, the volcanic history of Crater Lake since the 6850 b.p. eruption has been a peaceful one, as stated in the oral tradition.

Thunder, earthquakes, nearby volcanic eruptions, the filling of the lake and knowledge of its great depth, are all effects that occurred after the actual climactic eruption. However, they may have been incorporated into the oral tradition over time. This is common within oral traditions – to have multi-layered meanings and a coexistence of past and present components (Cruikshank 1990, 1998; Vansina 1961, 1985). Moreover, it is possible that these events did occur at the time of the event as well. Again, thunder and lightning could have resulted from the steam clouds blown into the air. Mt. Shasta (and other nearby volcanoes such as Newberry, Three Sisters, Mt. Jefferson and Mt. Hood) have erupted catastrophically every 600 to 800 years during the Holocene (Renfro 1992). So, it may be possible that the other nearby volcanic activity (referred to in the oral tradition) was one of these eruptions. Also, if natives were present during the eruption, and remained there for generations, then they could have witnessed the 'filling' of the lake. This would explain how they knew the great depth of the Crater Lake. While it would have been difficult for human life to persist within visual range of the crater during the eruption, people likely climbed up to the edge of Crater Lake after the eruption ceased and slope stabilization had occurred. By that time, the lake could have been partially or completely full. Regardless of whether these events occurred at the time of the event, or were added later, they both support the idea that natives were present during the eruption, were aware of how the local topography had changed, and transferred this information over millennia.

Rapid abandonment of the surrounding region after the eruption would seem to be a logical scenario (Torrence et al. 2000). But this is not known for sure, because the archaeological record for all periods is relatively scarce due to the generally low

populations and high mobility of local native groups. Sheets et al (1991) performed a comparative study of two prehistoric Central American populations. They determined that despite experiencing 10 explosive eruptions during 4,000 years, a remarkable cultural stability persisted. According to Sheets et al (1991:446), simpler societies "appear to be more resilient in the aftermath of explosive eruptions" than complex ones.

There are other references to consider. The notion of a long-term indigenous occupation near Crater Lake may be supported by other Crater Lake legends, such as "Crater Lake and the Two Hunters" (Clark 1953). This particular legend describes the depth of Crater Lake as a "cave (that) is deep and bottomless – as deep and bottomless as the sky". This legend stresses the great depth of the lake, which is the deepest lake in North America.

Secondly, Crater Lake today appears to be a beautiful and peaceful place. Then why are there so many stories of native groups being terrified of it? How would natives know of the awesome power that Mt. Mazama displayed unless it was witnessed? If Mazama has been dormant since 6850 b.p., then why is it so feared? Also, the local environment probably would have been habitable soon after the eruption (for example, in the Krakatau eruption of A.D. 1883, 50 years later the surrounding areas were covered in lush, dense forests (James et al 2000:332). It would seem that Crater Lake also would have been an important fresh water source, but archaeological evidence for such use is scarce. That probably reflects the very steep, unstable high sides of the crater, resulting in little or no habitable flat land at water level. Only a small number of artifacts (points, etc) have been found around the crater rim, indicating limited hunting expeditions or ceremonial offerings. This was clearly a feared place. In 1886, the Portland Oregonian reported that:

> There is probably no point of interest in America that so completely overcomes the ordinary Indian with fear as Crater lake. From time

> immemorial no power has been strong enough to induce them to approach within sight of it. For a paltry sum they will engage to guide you thither, but before reaching the mountain top will leave you to proceed alone. To the savage mind it is clothed with a deep veil of mystery and is the abode of all manner of demons and unshapely monsters. (Winthorp 1997)

In 1896, other media described Crater Lake as "a fantastic object of unspeakable dread to the Klamath Indians" (Winthorp 1997).

There are several other global native accounts that appear to depict volcanic events of the past. However, it is the antiquity and strength of correlation to the geological record that make the Klamath account of the formation of Crater Lake so valuable and unique. A devastating eruption, very similar to Mt. Mazama, took place in Indonesia in 1883, when Mt. Krakatau erupted with a Volcanic Explosivity Index (VEI) of 6 (as forementioned, Mt. Mazama in 6850 b.p.. had a VEI of 7). Krakatau also produced an enormous caldera through a nearly identical volcanic sequence. The 1883 Krakatau eruption has been described as "a turning point in history" for its contribution to the knowledge of volcanism (more specifically, the formation of calderas) and meteorology, since it was rigorously documented.

Thus, it is fascinating to note that in 1865, nearly 20 years before the Krakatau eruption, a young soldier stationed at Fort Klamath could record a story of the formation of Crater Lake, recited by a native chief, that correctly described the rare sequence of events that can form a caldera, that still was a hotly contested topic among American scholars well into the mid-twentieth century. For instance, Warren Smith, a ranger and naturalist in Crater Lake National Park during the 1930's, stated in his notes that "...just exactly what and how it happened is not so easy to decide...for many competent geologists do not agree as to just what did transpire" (Smith 1934:7). Actually, there was a trend towards the theory of explosion because "on purely mechanical grounds collapse of a great mass when so much material has been previously extruded violently does not seem to be reasonable" (Smith 1934:7). Especially interesting, in 1928, scholars were using the term

'caldera' to describe Crater Lake (Homuth 1928:1(2)), even though they still were uncertain as to how it was formed, epitomizing the questions surrounding its origin during the early and mid-twentieth century.

The Klamath account does not refer to the formation of the (neighbouring) Newberry caldera. In fact, it was formed by multiple eruptions over thousands of years, pre-dating and post-dating the Mazama climactic eruption. The magnitude of each such event was not comparable to the formation of Crater Lake. Therefore, it is highly unlikely that the Klamath would have chosen to remember those lesser events, especially considering the fact that only 110 kilometres separate Crater Lake and the Newberry caldera. Moreover, about 1,300 years ago, the Newberry volcano also produced what is now known as "The Big Obsidian Flow". Although that event was of extreme importance for the local native inhabitants, producing a seemingly endless supply of obsidian that was extensively traded, it was not catastrophic and did not profoundly change the environment, or physically affect the people. Thus, it does not appear to be referred to in the Klamath legend of the origin of Crater Lake.

So just how did natives, having no scientific knowledge of the principles of geology and volcanology, correctly deduce the formation of Crater Lake? The late nineteenth and early twentieth century was a time when geology itself was just solidifying its principles as a discipline. Yet natives understood a complex sequence of rare events that took geology decades to determine. The Klamath account of the eruption of Mt. Mazama and subsequent formation of Crater Lake contains a remarkable number of geological facts. Therefore, it seems inconceivable that this was a result of coincidence. The Klamath (or another ancestrally related group) must have been present to witness the event – or at least recognized the changes that occurred there within one human generation.

The Bonneville/Cascade Landslide: A.D.1100/1600

Another catastrophic paleoenvironmental event in the Oregon-Washington State region, that appears to be represented in native oral traditions, is the Bonneville or Cascade landslide, which occurred in the Columbia Gorge approximately 45 kilometres east of Portland. It covered an immense area, temporarily damming the Columbia River and resulting in a substantial backwater lake. Eventually, the river broke through the dam and reconstructed the modern Columbia River gorge downstream. This event likely led to local native oral traditions about the "Bridge of the Gods." (Adams 1904; Bunnell 1933; Harris 1985b, 1990, 2000; Hill 1999; Lawrence and Lawrence 1958; O'Conner et al. 1996)

The Bonneville/Cascade landslide is one of North America's most studied landslides (Harris 1985a, 1990). However, the exact date when the main slide occurred and its precise effect on the landscape and people are still debated. Moreover, often slides tend to re-occur in areas that have experienced many previous such events, making it somewhat difficult to make distinctions between them.

Based on archaeological, geological and sedimentological evidence, the estimated date for the latest Bonneville/Cascade landslide has traditionally been set at A.D. 1100. In particular, Rick Minor, an archaeologist for the U.S. Army Corps of Engineers, compared radiocarbon dates of wood samples taken in 1978 from within and below landslide deposits with radiocarbon dates obtained from archaeological sites in the landslide and flood area (Hill 1999). He determined that the landslide took place about A.D.1100.

However, some scholars were skeptical, because they felt that the submerged trees upstream from the Cascades observed by Lewis and Clark in 1805 would have decomposed had they been that old (Hill 1999). Thus, they redated other wood samples from the same context. Resulting dates from the core of a Douglas fir buried nearly 50 metres under the massive slide indicate that it killed the fir about 400 years ago and

perhaps as recently as 250 years ago (Hill 1999). That would suggest that the landslide (or multiple slides) occurred nearly five hundred years later than previously thought. If this proves correct, the landslide could have been contemporaneous with the Cascadia megathrust earthquake of A.D.1700 (which will be discussed in further detail later), thereby suggesting that it triggered that giant landslide.

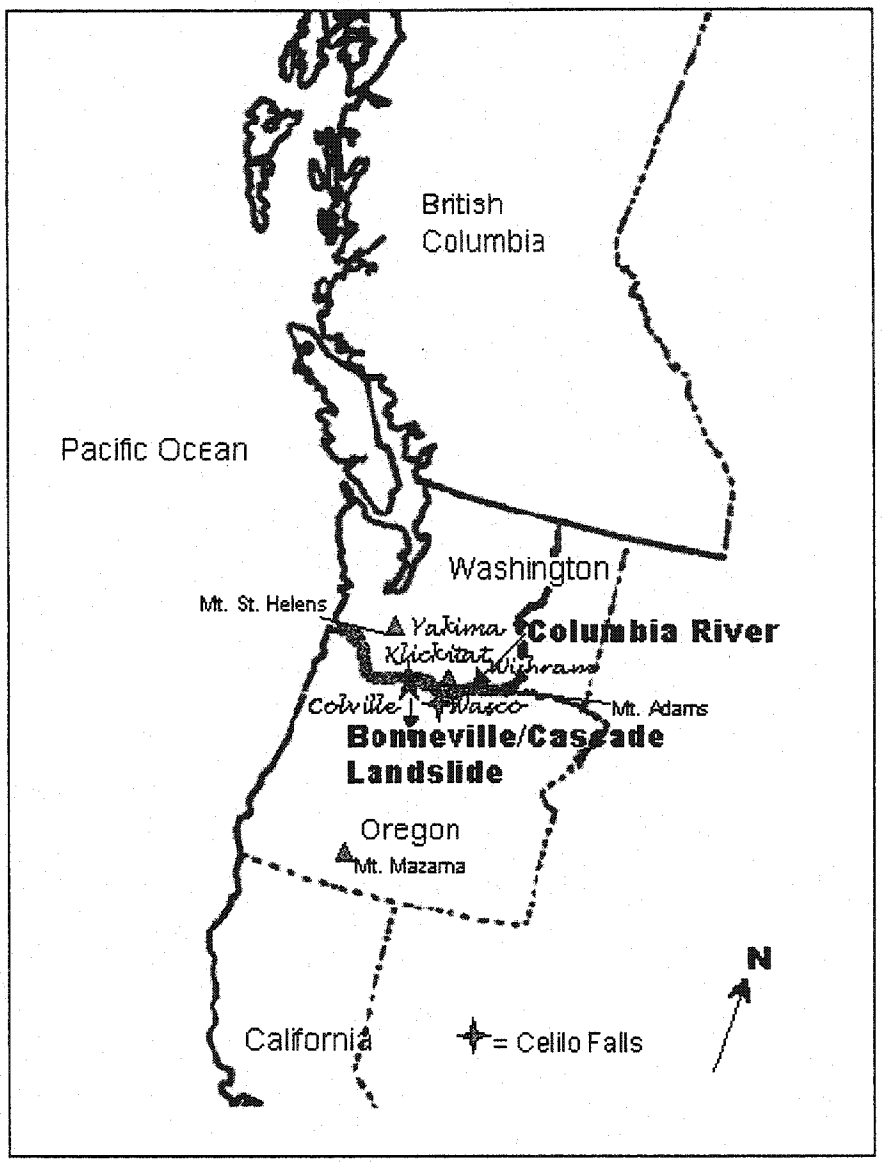


Figure 8: Location of the Bonneville/Cascade Landslide Area and Surrounding Columbia River, with Historic Locations of Local Native Groups

Environment

Paleoenvironmental research reveals that variations in the timing and amounts of precipitation, coupled with changes in temperature and vegetation cover, resulted in a cyclical pattern of high and low flood potentials along the Columbia in the last 2000 years (Chatters and Hoover 1986:318). For instance, practically each generation that occupied

the Plateau between 1000 and 600 years ago experienced a large scale flood of a magnitude equal to or even greater than the most severe flood of post-contact times.

Native Inhabitants

Proto-historic and historic native cultures varied greatly along the length of the Columbia River. On the lower Columbia, ethnographic groups lived in Northwest Coast style large multi-family plank houses, while on the middle and upper river sections, Plateau people moved more regularly and stayed in smaller groups. Ethnographic native fishers of the lower Columbia area took salmon at Willamette Falls on the Willamette River and at Kettle Falls on the upper Columbia. However, Celilo Falls at The Dalles on the lower river was the most important native fishery. Thousands gathered there during the spring and summer to harvest salmon and trade.

Again, due to the probable mobility of prehistoric indigenous populations, it is difficult to be certain which ethnolinguistic groups were locally present at the time of the landslide. However, since that landslide did not occur much before European contact, it is likely that at least of some groups were then living in their historic locations. In fact, anthropological and archaeological evidence, in addition to legends and oral traditions, indicate that the Klickitat, Wishram, Yakima, Wasco, and Colville groups were likely inhabitants in the area at the time of the landslide (figure 8).

The Columbia Plateau area also was dramatically affected by the repeated introduction of European diseases after contact, with the first outbreak decimating the native population around 1770. From an original population estimated at 100,000, the native population of the Columbia Plateau declined to under 10,000 by 1850 (Boyd 1990:17). This astonishing decline in native population obviously had severe effects on

the continuance of traditions about the Bridge of the Gods, and undoubtedly, many detailed accounts of the landslide were lost.

Archaeology

As mentioned earlier, several nineteenth century explorers, scholars and missionaries (e.g. Lewis and Clark 1893, De Smet 1905, Emmons 1887, Hines 1851, Strong 1893) noted submerged trees and calm currents on the upper (east) side of the Cascades, "What is, however, most singular is that there are stumps of pine-trees scattered some distance on the river, which has the appearance of being dammed below and forced to encroach on the shore" (October 30th, 1805, diary of Lewis and Clark 1893:678-679).

Gaining information from archaeological remains near the slide area is quite problematic because any evidence of previously existing villages or seasonal camps were destroyed, either by the slide, or by the later filling and catastrophic emptying of the lake. Modern hydroelectric reservoir construction would have further impacted the archaeological record. However, we can be certain that the landslide had a significant impact on the native inhabitants.

Accumulated archaeological evidence indicates that the total span of human occupation in the Columbia River gorge area is at least 10,000 years. The predominance of fishing in the subsistence patterns of the local groups of the slide area is apparent in the archaeological and ethnographic evidence. Celilo Falls, just east of the Cascade rapids, was one of the most abundant salmon fishing areas in North America (Hines 1851; Lawrence and Lawrence 1958). Here the river dropped into long, narrow, deep channels formed in volcanic rocks. The crest narrowed and plunged over the cliffs of the Grand Rapids, Great Falls, and Dalles (McKee 1972), all of which provided ideal fishing spots. Fish would be caught by line, net, or harpoon from slippery rocks, or precarious wooden platforms constructed over the rapids. The Wasco controlled the Oregon side of the river,

while the Wishram controlled the Washington side (Johansen and Gates 1967). Celilo Falls and the Cascade landslide area constituted the two best natural fish traps along the Columbia River. The Bonneville slide area also was likely a sacred place for local natives – especially after the main slide occurred. At certain times of the year, probably during the salmon run, it also became a communal gathering area, with extensive trade in shell, baskets, rabbits, bear skin robes and mountain sheep. De Smet (1905:556) states that "Indians flock thither from different quarters of the interior, to attend, at this season of the year...this is their glorious time for rejoicing, gambling and feasting...they have at last assembled in the midst of abundance – all that the eye can see, or the nose can smell, is fish, and nothing but fish". Moreover, Lawrence and Lawrence (1958:41) reported that natives told stories about how Celilo Falls (just east of The Dalles) originally were too high for salmon to jump over, but raised water levels produced by the landslide allowed some to get by. Therefore, the Bonneville/Cascade landslide produced a natural fish ladder, which significantly increased salmon access to spawning grounds upstream.

Analysis of Catastrophe

The magnitude of the land displacement and extent of the backwater associated with the landslide are far less debated than the exact date of its occurrence. The landslide event was undoubtedly cataclysmic in nature and not a slow, creeping slide as some have suggested in the past (Lawrence and Lawrence 1958). Geoarchaeological, sedimentological, and topographical evidence support this assertion.

Basically, a closely spaced series of four immense landslides (consisting of parts of the several lava layers that form Table Mountain) detached from the north side of the Columbia River Gorge and slid southwards, thereby blocking the river and forming a large backwater (figure 9). The instability of the land prior to the slide event has been compared to a deck of cards tilted towards the river (Hill 1999). In other words, it did not

necessarily need a large magnitude earthquake to trigger the landslide. It is impossible to accurately determine how much land was displaced, or especially the volume of the lake that would have formed as a result of the dam. However, considering the geometry of the landslide and the valley upstream, the landslide dam could have held back 21 cubic kilometres of water before overflowing (O'Connor et al. 1996). Several estimates have the bridge as high as 100 metres (Harris 1990; Lawrence and Lawrence 1958), and several metres wide, making it feasible to briefly walk across on foot. If this was the case, the lake formed by such a dam could have been up to 150 kilometres long. Again, there is still evidence for drowned forests and submerged trees east of the Cascades stretching east of the Dalles, as noted by Lewis and Clark (1893). It is not known how long the bridge would have lasted, but to produce such a large lake, it easily could have been several years (Harris 1990).

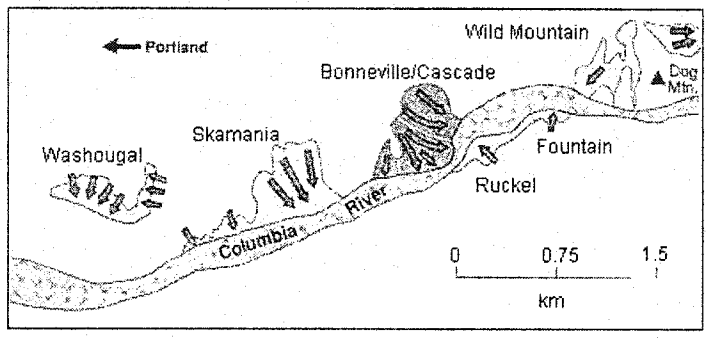


Figure 9: The Bonneville/Cascade Landslide and Other Known Landslides Along the Columbia River Gorge
(Harris 1990:212)

Eventually, the backwater became too high, overflowed the dam, quickly eroding most of it and leaving only those rock remnants that were too heavy to carry away. Those remnants formed the modern Cascades. The river's course also was permanently changed, as the slide debris bent its channel southwards.

The Cascade Rapids, formed from what remained of the Bridge of the Gods, was one of the most treacherous portions of the historic Oregon Trail. Euroamerican settlers had to choose between risking a boat trip down the rapids, or continuing over a rocky trail along the canyon. The rapids continued to make travel on the Columbia River hazardous until the Cascade Locks were built in 1896. In 1938, the rapids disappeared under water rising behind the newly built Bonneville Dam.

Related Geological Activity

Nearby volcanic eruptions (because of associated earth tremors) and/or larger scale earthquakes could have triggered the landslide that produced the Bridge of the Gods. Of course, given the unstable nature of the Columbia Gorge walls, it would not necessarily have required a large magnitude event. While small-scale tremors locally associated with volcanic eruptions and those larger tremors associated with regional earthquakes are both forms of seismiturbation, they may be represented quite differently in oral traditions. The following is a summary of known factors that could have prompted the creation and destruction of the Bridge of the Gods.

Volcanic Activity

There are three active volcanoes in the immediate area that, if they erupted, could have caused ground movement that may have triggered the landslide. Mt. Hood, Mt. Adams, and Mt. St. Helens all have had eruptive episodes in the past significant enough to cause such activity. Mt. Hood had two eruptive episodes between 1400-1800 b.p. and 400-600 b.p., with major pyroclastic flows dated to 1450 b.p. and 450 b.p. (Crandell 1980; Cameron and Pringle 1986). A significant lahar occurred on Mt. Adams at approximately 2000 b.p., with four tephra falls occurring between 1100-800 b.p. (Scott et al. 1995). Mt. St. Helens has catastrophically erupted at least 15 times within the last 4,000 years. It is

the most active volcano in the Pacific Northwest, hence the most extensively studied. During the past 4,000 years, for example, it has produced more than 50 identifiable tephra strata, numerous pyroclastic-flow and lahar deposits, several lava domes, and lava that flowed down all sides of the volcano. Mt. St. Helens had several eruptive periods possibly relevant to the Bonneville/Cascade landslide. Thus, about 1,200 years ago, the volcano first erupted quietly to produce a dome, and then twice violently, producing a small volume of tephra, directed-blast deposits, pyroclastic flows, and lahars (Crandell and Hoblitt, 1986; Crandell, 1980). In the last 515 years, it is known to have experienced 4 major explosive eruptions (each producing at least 1 cubic kilometer of eruption deposits) and numerous lesser eruptions. Two of the major eruptions were separated by only 2 years. One of those, in A.D.1480, was about 5 times larger than the May 18, 1980 eruption (Wolfe and Pierson, 1995), and resulted in a highly explosive pumice eruption including significant ejections of tephra and lava flows (Mullineaux 1986). Later, in A.D.1800, another highly explosive eruption occurred, while the last major eruption took place in 1980.

Earthquakes

Undoubtedly, thousands of earthquakes could have occurred near the Bonneville/Cascade landslide area during the time of the actual slide, given the geology of the region. Although it is not known for sure if such an event would have triggered that landslide, large magnitude earthquakes occurred at 300 b.p. and 950 b.p., which happen to roughly coincide with both of the possible dates for the landslide. Researchers (Adams 1992; Atwater and Moore 1992; Bucknam et al 1992; Karlin and Abella 1992; Schuster et al. 1992) have unequivocally shown that there also was a large magnitude earthquake in the Seattle area about 1000 b.p. Evidence of a large tsunami off the coast of Puget Sound, and elsewhere on the Pacific Northwest Coast (Hutchinson and McMillan 1997,

McMillan and Hutchinson 2002), and six prehistoric rock avalanches in the Olympic Mountains at about the same time, lead researchers to believe that this earthquake was greater than 7 on the Richter scale.

The earliest and largest historically recorded earthquake centered in the Pacific Northwest was a megathrust earthquake of A.D. 1700. Tsunamis related to this earthquake were recorded in Japan hours after the earthquake, which has been estimated at 9.2 magnitude on the Richter scale, and was caused by the movement of subcontinental plates. It is the most devastating type of earthquake that can occur. There are native accounts of villages being destroyed by such an earthquake and tsunami action that will be addressed later in this study.

Flooding

The largest flood that occurred within the last 1,500 years on the Columbia River was likely the result of the breach of that natural dam created by the Bonneville/Cascade landslide. The lake had extended east of the dam along the Columbia River for over 100 kilometres. Eventually, the water broke through the slide debris and swept downstream towards the ocean. O'Connor et al (1996) have estimated that occurred between A.D.1400 and A.D.1480. Waves up to 20 metres tall crashed down the gorge, flooding what is now Portland, and people were certainly directly affected, if not killed. Archaeologists believe the catastrophic flood also washed away evidence of thousands of years of downstream human occupation. However, it is also possible that some other event – such as a tsunami started within the lake itself, could have caused the destruction of the natural land bridge. The highly unstable walls of the upstream gorge and valley were submerged as the giant backwater lake formed after the damming of the Columbia River. Eventually, that might have triggered a larger landslide upstream, displacing water and triggering a small tsunami in the lake. If it was large enough, that could have aided in

either the overflowing or destruction of the downstream "Bridge of the Gods". This is not an uncommon occurrence. A good example of this type of phenomenon occurred in Lituya Bay, Alaska in 1964, where a large landslide displaced a mass of water, producing a tsunami that traveled the length of the entire bay, causing significant damage to the harbor area (Plafker 1972).

Oral Traditions

There are numerous native legends about the Bridge of the Gods. However, this study will focus only on those that pay particular attention to the actual formation and destruction of the Bonneville/Cascade landslide. Perhaps the best known account of the Bridge of the Gods is the Klickitat version from Ella Clark's 1953 compilation *Indian Legends of the Pacific Northwest* (p.20-23).

> Long ago, when the world was young, all people were happy. The Great Spirit, whose home is in the sun, gave them all they needed. No one was hungry, no one was cold.
>
> But after a while, two brothers quarreled over the land. The older one wanted most of it, and the younger one wanted most of it. The Great Spirit decided to stop the quarrel. One night while the brothers were asleep he took them to a new land, to a country with high mountains. Between the mountains flowed a big river.
>
> The Great Spirit took the two brothers to the top of the high mountains and wakened them. They saw that the new country was rich and beautiful.
>
> "Each of you will shoot an arrow in opposite directions," he said to them. "Then you will follow your arrow. Where your arrow falls, that will be your country. There you will become a great chief. The river will separate your lands."
>
> One brother shot his arrow south into the valley of the Willamette River. He became the father and the high chief of the Multnomah people. The other brother shot his arrow north into the Klickitat country. He became the father and high chief of the Klickitat people.
>
> Then the Great Spirit built a bridge over the big river. To each brother he said, "I have built a bridge over the river, so that you and your people may visit those on the other side. It will be a sign of peace between you. As long as you and your people are good and are friendly with each other, this bridge of the Tahmahnawis will remain."

It was a broad bridge, wide enough for many people and many ponies to walk across at one time. For many snows the people were at peace and crossed the river for friendly visits. But after a time they did wicked things. They were selfish and greedy, and they quarreled. The Great Spirit, displeased again, punished them by keeping the sun from shining. The people had no fire, and when the winter rains came, they were cold.

Then they began to be sorry for what they had done, and they begged the Great Spirit for fire. "Give us fire, or we will die from the cold," they prayed. The heart of the Great Spirit was softened by their prayer. He went to an old woman who had kept herself from the wrongdoing of her people and so still had some fire in her lodge.

"If you will share your fire, I will grant you anything you wish," the Great Spirit promised her. "What do you want most?"

"Youth and beauty," answered the old woman promptly. "I wish to be young again, and to be beautiful."

"You shall be young and beautiful tomorrow morning," promised the Great Spirit. "Take your fire to the bridge, so that the people on both sides of the river can get it easily. Keep it burning there always as a reminder of the goodness and kindness of the Great Spirit."

The old woman, whose name was Loo-wit, did as he said. Then the Great Spirit commanded the sun to shine again. When it rose the next morning, it was surprised to see a young and beautiful maiden sitting beside a fire on the Bridge of the Gods. The people, too, saw the fire, and soon their lodges were warm again. For many moons all was peaceful on both sides of the great river and the bridge.

The young men also saw the fire and the beautiful young woman who attended it. They visited her often. Loo-wit's heart was stirred by two of them - a handsome young chief from south of the river, whose name was Wyeast, and a handsome young chief from north of the river, whose name was Klickitat. She could not decide which of the two she liked better.

Wyeast and Klickitat grew jealous of each other and soon began to quarrel. They became so angry that they fought. Their people also took up the quarrel, so that there was much fighting on both sides of the river. Many warriors were killed.

This time the Great Spirit was made angry by the wickedness of the people. He broke down the Bridge of the Gods, the sign of peace between the two tribes, and its rocks fell into the river. He changed the two chiefs into mountains. Some say that they continued to quarrel over Loo-wit even after they were mountain peaks. They caused sheets of flame to burst forth, and they hurled hot rocks at each other. Not thrown far enough, many fell into the river and blocked it. That is why the Columbia is very narrow and the water very swift at The Dalles.

Loo-wit was changed into a snow-capped peak which still has the youth and beauty promised by the Great Spirit. She is now called Mount St. Helens. Wyeast

is known as Mount Hood, and Klickitat as Mount Adams. The rocks and the white water where the Bridge of the Gods fell are known as the Cascades of the Columbia.

Klickitat version of the Bridge of the Gods legend (Clark 1953:20).

Thus, Klickitat became Mt. Adams, Wyeast became Mt. Hood, and Loo-wit became Mt. St. Helens. There are other different versions of this legend among the various tribes (Neils 1985), but they all essentially tell the same story, that Mt. Adams and Mt. Hood continued their battle over Mt. St. Helens by throwing giant rocks at each other, spewing forth fire and smoke, and shaking the ground. Eventually they caused massive earthquakes that destroyed the land bridge across the Columbia River

The next legend is a Colville account. Essentially, it describes the formation of the Bonneville/Cascade landslide in the same manner. However, it includes other apparent historical information, such as the interactivity with salmon and the existence of a large lake.

> Long ago, when Coyote was the big man on the earth, this valley was covered by a big lake. At that time there was no Columbia River. West of us, between the lake and the ocean, was a long ridge of mountains. But the Columbia River did not go through it. Indians today believe that.
>
> Coyote was smart enough to see that salmon would come up from the ocean to be food for his people here if he would make a hole through the mountains. So he went down to a place near where Portland is now, and with his powers he dug a hole through the mountains there. The water went through the hole and on to the ocean.
>
> The water in the big lake up here was drained, and the water flowing out of it made the Columbia River. Coyote got the Columbia to flow through that hole, the way it does today. Then the salmon came up the river to this part of the country. His people after that had plenty to eat.
>
> When he dug that hole through the mountains, Coyote made a kind of bridge. You have heard about it--a broad rock bridge that went across the river. People could walk from one side of the Columbia to the other. A long time afterward, an

earthquake broke the bridge down. The rocks that fell into the water formed the Cascades of the Columbia. They made it hard for boats to go up and down the river there.

A Colville account of the Bridge of the Gods. "How Coyote Made the Columbia River" (Clark 1953:88)

This version of the story was told in 1951 by Peter Noyes, a Colville Indian who claimed he had first heard it nearly 80 years previously. (Clark 1953:88)

The Wasco also have a descriptive account of the Bridge of the Gods. In this version, recorded in 1914 by local rancher and scholar Lucullus McWhorter, a native storyteller describes its existence. The following is a relevant excerpt from a much more lengthy and detailed account:

> Coyote, above him and invisible, now brought a greater noise than ever, a crash like the bursting of this world. The five laws, the five mountains, crumbled and fell. The fragments, floating down the nChe-wana, created the many islands along its course. The giant body of Noh-we-nah klah [Thunder-bird] formed the great Bridge across the wana at the Cascades. This Bridge was of the first mountain and was mostly stone. It stood for many hundreds of snows, no one knows how long, and then it fell. The Indians said that in time it would fall and it did. Some of my ancestors, old people, saw and passed under that Bridge. I do not know the number of snows since that time, but there are many. (Trafzer 1998:197-202)

During the nineteenth century, there were numerous European explorers and missionaries who traveled and lived along the Columbia River. Their journals record some of the first accounts of meetings with indigenous populations. Since the visible remains of the Cascade landslide site were awe inspiring, travelers were compelled to record their observations and explanations. These explanations often also included indigenous interpretations. The following was recorded by Reverend Gustavus Hines (1851:155) on May 2nd, 1843, while traveling through the Cascades;

> At this place the Columbia rushes through the Cascade range of mountains, and the channel through which it pours its mighty torrent, appears not more than thirty rods wide, while each shore presents indubitable evidence that, by a vast accumulation of water above, these mountain barriers were torn asunder, and thus this mighty river found its way to the Pacific ocean. The Indians here have a

> tradition that, a long time ago, the mountain was joined together over the river, and that the river performed a subterraneous passage for some distance, with a slow current, and that their people used to pass up and down with their canoes without difficulty; but all at once the foundations of this mighty arch crumbled beneath their ponderous weight, and the whole mass came tumbling into the river, filling up the channel and quite damming up the stream, and thus were formed the beautiful Cascades.... Found the river wide above the Cascades, with little current, and, from appearances, were convinced that the Indian tradition concerning the falling in of the mountain, is not without foundation.

Another missionary, Father Pierre-Jean DeSmet, was returning to the upper missions (east of the Cascades) in July, 1846, when he recorded the native account of the Cascades:

> There is an interesting and very plausible Indian account of the formation of these far-famed Cascades, on which so much has been said and written, so many conjectures regarding earthslides, sinks or swells, caused by subterraneous volcanic agents. "Our grandfathers," said an Indian to me, "remember the time when the waters passed here quietly and without obstruction, under a long range of towering and projecting rocks, which, unable to bear their weight any longer, crumbled down, thus stopping up and raising the bed of the river; then it overflowed the great forests of cedar and pine, which are still to be seen above the Cascades." Indeed, the traveler beholds with astonishment a great number of huge tree trunks, still standing upright in water about twenty feet deep. No person, in my opinion, can form a just idea of the cause that produced these remarkable changes, without admitting the Indian narrative. (De Smet 1905:555)

In September of 1834, while traveling along the Columbia River, Lee and Frost (1968:199-200) noted that:

> The Cascades appear to be of a comparatively recent date, perhaps formed within the last three or four centuries...The Indians say that these falls are not ancient, and that their fathers voyaged without obstruction in their canoes as far as the Dalles. They also assert that the river was dammed up at this place, which caused the waters to rise to a great height far above, and that after cutting a passage through the impending mass down to its present bed, these rapids first made their appearance...Admit a dam at the Cascades, and these appearances perplex no more, their origin seems natural.

There are also some passages in the literature that describe a large earthquake directly preceding the destruction of the Bridge of the Gods. James Strong (1893), while hunting in Yakima country in 1854, recorded an account of the legendary bridge from an old native man. He spoke of how his grandfather remembered when "there were no rapids. The spirit of Mt. St. Helens and the spirit of Mt. Hood used to go across the

natural bridge to visit each other. But one day, the spirit of St. Helens became very angry and shook it down" (Strong 1893:135). Ella Clark (1952:34-35) also states that "One night the earth began to shake and to tremble. The mountain demons belched forth flaming thunderbolts and hurled hot stones upon the water below...the Bridge of the Gods fell."

These accounts are first hand, recorded by white explorers, settlers, missionaries, etc, at or near the time of European contact. Other later accounts exist (Attwell 1973; Bunnell 1933) that claim to tell a similar tale of the Bridge of the Gods. Attwell's (1973:61) version states "... and when the moon became directly overhead, each mountain would open their tops and hurl large boulders at the mountain bridge, causing it to collapse into the river". Bunnell (1933:49) states "they (Gods) threw so many large stones onto the Bridge of the Gods and shock the earth so hard that the bridge broke in the middle and fell, a jumbled mass, into the river far below". Although the authors of these accounts claim to retell the stories as they were told to them decades earlier, of course it is impossible to determine the extent of possible embellishment and modern influence that became appropriated within them. However, the passages above are consistent with those earlier, first hand accounts.

Comparative Analysis

The most complete and detailed account of the Bridge of the Gods is seen in the Klickitat account quoted by Clark (1953:20). Thus, it is the most appropriate account to analyze in the qualitative table (table 3). Again, apparently relevant passages from the oral tradition are in the first column, while corresponding geological and archaeological evidence follows in the second column.

	Native Oral Account		Geological Account
	Long ago, when the world was young, all people were happy. The Great Spirit, whose home is in the sun, gave them all they needed. No one was hungry, no one was cold.		No correlation
Pre-Event	But after a while, two brothers quarreled over the land. The older one wanted most of it, and the younger one wanted most of it. The Great Spirit decided to stop the quarrel. One night while the brothers were asleep he took them to a new land, to a country with high mountains. Between the mountains flowed a big river.		Basically, a physical description of the surrounding environment. The Columbia River is a large river that flows between Mt. Hood and Mt. Adams.
	Then the Great Spirit built a bridge over the big river. To each brother he said, "I have built a bridge over the river, so that you and your people may visit those on the other side. It will be a sign of peace between you. As long as you and your people are good and are friendly with each other, this bridge of the Tahmahnawis will remain."		Implies that an instantaneous event occurred, as performed by the 'Great Spirit'. The land bridge was a series of landslides from the north side of the Columbia gorge at what is now known as the Cascades.
	It was a broad bridge, wide enough for many people and many ponies to walk across at one time. For many snows the people were at peace and crossed the river for friendly visits.		Several estimates have the bridge as high as 100 metres (Harris 1990; Lawrence and Lawrence 1958). If this is the case, the lake formed by the dam would have been approximately 150 kilometres long. Again, there is evidence for drowned forests and submerged trees east of the Cascades stretching east of the Dalles (Lawrence and Lawrence 1958:35). It is not known how long the bridge would have lasted, but to produce such a large lake, it very easily could have been several years. Horses were introduced in the Washington and Oregon territories about A.D.1700. (Zucker et al. 1983)

During Event	Wyeast (Mt. Hood) and Klickitat (Mt. Adams) grew jealous of each other and soon began to quarrel. They became so angry that they fought. Their people also took up the quarrel, so that there was much fighting on both sides of the river. Many warriors were killed.		Mt. Hood had eruptive episodes between A.D.1400 and A.D.1800, and later between A.D.400 and A.D.600. Mt. Adams had eruptive episodes between A.D.100 and A.D.800 as well as a lahar flow around A.D.500. Mt. St. Helens has had several major eruptions – A.D.1800, a very large one in A.D.1480, A.D.1200, and other lesser episodes in between.
	This time the Great Spirit was made angry by the wickedness of the people. He broke down the Bridge of the Gods, the sign of peace between the two tribes, and its rocks fell into the river.		The natural land dam formed by the Bonneville/Cascade landslide broke as a result of either an earthquake, a nearby catastrophic volcanic eruption, or the overtopping of the backwater formed by the landslide. The most likely scenario is that the lake formed by the landslide eventually overflowed and quickly eroded most of the dam. Some of the rocks were too large for the current to carry downstream and thus formed the Cascades.
	Some say that they continued to quarrel over Loo-wit even after they were mountain peaks. They caused sheets of flame to burst forth, and they hurled hot rocks at each other. Not thrown far enough, many fell into the river and blocked it.		A general description of lahar, pyroclastic and/or lava flows, and the ejection of tephra. It is not possible that ejected material from any of the volcanoes would have been substantial enough to block the river where the Bonneville/Cascade landslide occurred.
Post-Event	That is why the Columbia is very narrow and the water very swift at The Dalles.		The Cascade rapids were formed as a result of the natural dam (bridge) collapsing once the backwater overflowed over the dam. The larger boulders were too heavy for the current to carry them, and thus remained.
Post-Event Adaptation	No description.		Once the river resumed its flow into the Pacific Ocean, its course was diverted nearly one kilometer to the south (at the location of the landslide). It became a very good natural fish trap and abundant resource area for natives. As a result, it also became a place of trade and ceremony.

Table 3: Descriptive Comparison of Geological Evidence and Oral Tradition

Discussion

There appear to have been some misunderstandings when the first explorers and settlers interpreted native accounts of the Bridge of the Gods. When early settlers arrived in Oregon, they heard the legends and misinterpreted the descriptions as an actual 'bridge' arching over the Columbia. However, geologists believe this to be very unlikely because the material from the landslide was primarily unstable rock and gravel. Instead, the river was dammed, causing the formation of a substantial lake. This misinterpretation made more sense when Barry (1932) showed that the native languages had no words that directly translated to the English word for 'bridge'. A literal translation showed that they merely stated that they could "cross the river without getting their feet wet" (Lawrence and Lawrence 1958:33).

There is also the possibility that there was some sort of visible, continued flow or 'seepage' beneath the pathway used to cross the river, which may have given the appearance that the land mass was indeed a bridge. This is a somewhat common phenomenon that can occur when loose rubble landslides obstruct rivers or waterways.

The description of the formation, existence and destruction of the bridge (Clark 1953:20) appears to correlate to the geological and archaeological accounts (as seen in table 3). It is plainly stated that the Great Spirit 'built' a bridge over the big river so people may visit those on the other side. In the same manner, the Great Spirit, once angered, 'broke down' the bridge and the rocks fell into the river. This description of the formation and destruction of the bridge implies essentially instantaneous occurrences. Legends and oral traditions often depict supreme beings, or 'Great Spirits', as creators or destroyers. Creation and destruction are not gradual and small-scale processes. They tend to be relatively sudden and large-scale acts that demonstrate the power of those supreme

beings. Geologically, the creation of the Bridge of the Gods was certainly instantaneous. If that bridge eventually was destroyed by a seismic event, then it too could have been instantaneous. If the backwater overflowed the bridge, the destruction still may have been rapid, but likely not as quick as a seismic event. Nevertheless, the water flow could have eroded the bridge very quickly. Either way, if witnessed by people, the process likely would have seemed significant enough to be recorded in their oral traditions.

There also appear to be similarities between the physical description of the bridge, as stated in the oral tradition, and the geological explanation of how the bridge may have appeared. The oral tradition states that the bridge was wide enough for several people and ponies to cross at the same time. Both Lawrence and Lawrence (1958) and Harris (1990) have estimated that the natural dam could have been as high as 100 metres. Moreover, in order for it to block the mighty Columbia River long enough to create a lake as large as 150 kilometres long, it must have had a significant thickness. Hence, the 'bridge' could easily have been wide enough for several people and animals to cross simultaneously. This oral tradition also states that the bridge lasted for several 'snows', which is likely to mean several winter seasons. In fact, in order to drown and kill forests hundreds of kilometres upstream, the river must have been dammed for several years.

There is also description of Mt. Hood (Wyeast) and Mt. Adams (Klickitat) quarreling with each other over Mt. St. Helens (Loo-Wit). This may be interpreted as indicating volcanic activity, and both Mt. Hood and Mt. Adams are known to have been erupting at that time. What does not seem to be indicated in the stories is that Mt. St. Helens was the most volcanically active mountain of the three. In all of the versions of the Bridge of the Gods, Mt. St. Helens is portrayed as the beautiful maiden that was fought over by the other two fierce combatants. She is never portrayed as 'fighting' or 'quarreling', (or being volcanically active herself), despite 'her' known high frequency of volcanic episodes, especially during the times of the landslide.

As illustrated in "How Coyote Built the Columbia River" (Clark 1953:88), Peter Noyes, a Colville Indian in 1951, told an account of the slide that he claimed he first heard over 80 years prior. However, if we accept the geological opinion, which states that a great stone arch spanning the entire river was physically impossible because of the nature of the loose sediment, then this particular account does not appear to correlate very well. As discussed earlier, the 'stone arch' interpretation was earlier attributed to misinterpretation by whites, who had difficulty translating the native word 'bridge'. If this account were indeed a result of actually witnessing the event, then one would presume that a native teller of this story would realize the problems with the literal translation, and acknowledge the discrepancy. In fact, it is more likely that his version includes portions of white mis-interpretations that have been secondarily re-incorporated into the native account.

Nevertheless, there still are correlates between this Colville version and the geological and archaeological record. For instance, the native account states that there was a time when no river existed west of the slide area and that there was only a great lake. Coyote, seeing that his people were not getting anything to eat, drained the lake by cutting a hole through the mountains, causing the river to flow again and salmon to come up the river. Of course, this is precisely what happened. As forementioned, the landslide blocked the river and caused the formation of a large lake. After some time, the dam broke, either by backwater overflow or some seismic or volcanic event. This formed the Cascade rapids, which turned out to be a formidable natural fish trap. This knowledge of geological events, and the sequence in which they can occur, is relatively detailed, and may be quite difficult to infer without actually witnessing such events.

Without question, there was a natural dam and substantial backwater, agreed upon from the earliest European explorers to the most recent geologists and archaeologists. That indicates that we must admit the fundamental 'truth' of (at least this particular) Indian narrative. However, what if the native narrative had not existed? Would European

explorers and scholars have arrived at the same explanations for the physical state of the Cascades? This is a difficult question to answer. There is potential to argue here that natives are good geologists. Since they are intimately involved with their environment, natives would have been aware of geomorphological and environmental processes through observation and interaction with them. So, it is possible that they could have inferred a past slide happening in this location, *even if they had no actual lasting 'memories' of such an event.*

Another consideration is that, in general, slide areas tend to reoccur in similar (if not exact) locations, and as seen in figure 9, there have been other landslides in the local area of the Bonneville/Cascade event. Thus, some may argue that the Bridge of the Gods oral tradition is an amalgam of many previous slide events. While this is possible, the fact remains that certain 'unique' details from that most recent Bonneville/Cascade landslide event are present within the oral traditions. Therefore, even if it incorporates other slides, it still contains historical information tied to that one particular geological event.

The evidence presented by O'Connor et al (1996) draws some especially interesting parallels between geological evidence and oral tradition. They show that an exceptionally large and catastrophic flood swept through the Columbia River gorge and valley between A.D.1400 and A.D.1480. An obvious explanation for a flood of such magnitude would have been the breeching of the Bridge of the Gods. As described earlier, during this time all three local volcanoes also were active. Mt. Hood produced several lahar and pyroclastic flows between 400 and 600 years ago, and Mt. Adams produced a notable lahar flow at 500 b.p. Moreover, Mt. St. Helens had two of the most explosive eruptions in its history between A.D.1479 and A.D.1480, with the latter at least five times larger than the eruption of May 18, 1980. Any one of these events could have produced the necessary seismiturbation to breach the landslide dam.

By accepting O'Connor et al (1996), the bridge probably was breeched sometime between 500 and 600 years ago (amidst significant local volcanic activity), causing a large flood to travel west. This is consistent with oral accounts that describe the mountains producing 'sheets of fire' and 'hurling hot rocks', as well as some flood accounts. The description of the 'ground shaking and trembling' does not necessarily describe an earthquake, and may actually be referring to local volcanic activity. The large magnitude eruption of Mt. St. Helens approximately 500 years ago would have produced a trembling and shaking that would have been felt throughout the Columbia Gorge. Therefore, it seems possible that all the environmental activity described in the oral traditions, was, indeed, present.

A.D.1700 Megathrust Earthquake/Tsunami

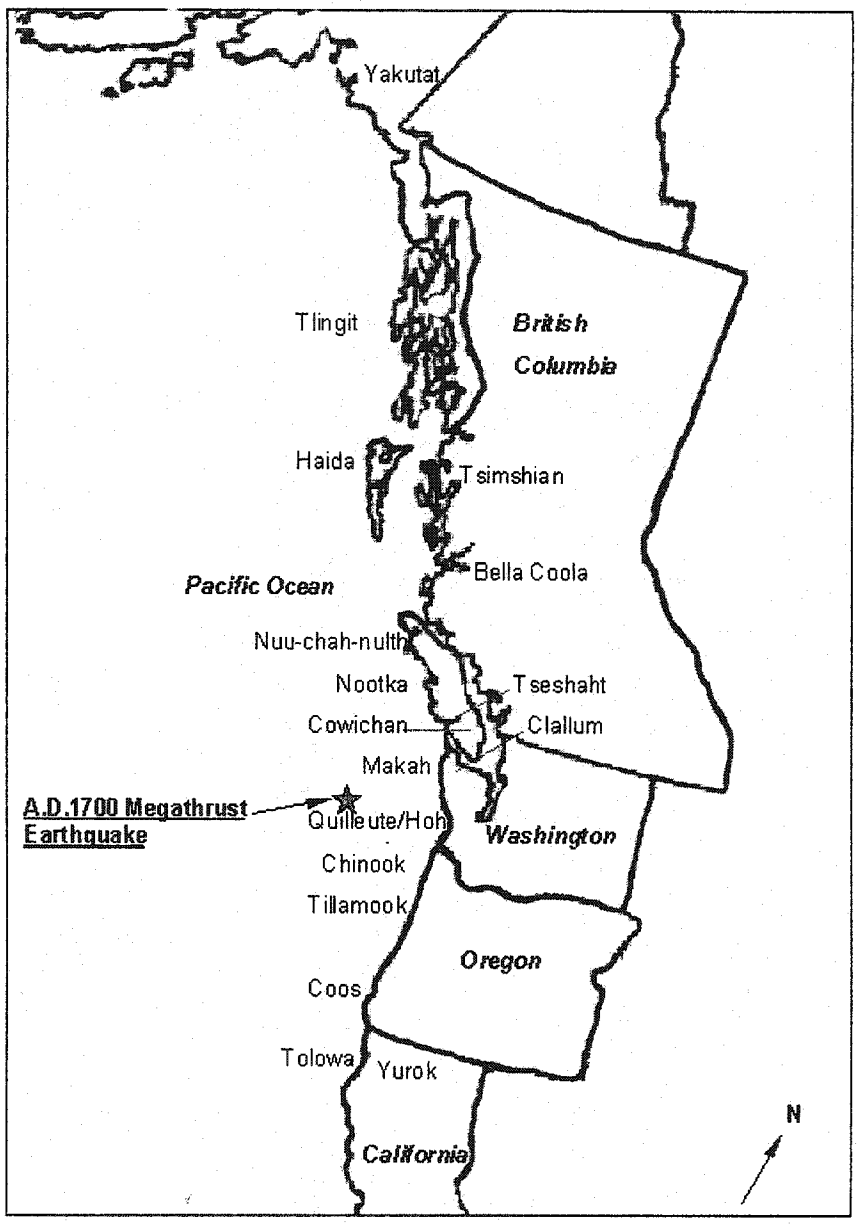


Figure 10: Map of the Location of the A.D.1700 Megathrust Earthquake with Historic Locations of Local Native Groups

Upon examination of numerous oral traditions of Pacific Northwest First Nations groups, it appears that a distinction may be made between oral traditions that are set in

'mythic' times, and ones that take place in the 'not so distant past'. Because of the relatively recent age of the A.D. 1700 Tsunami (just prior to European contact), an emphasis is made to find oral traditions that appear to depict tsunami-like events situated in the 'not so distant past'. But before it can determined whether or not a tsunami is being depicted within an oral tradition or legend, the concept of a 'tsunami' must be defined within the context of the A.D.1700 earthquake.

Earthquakes have been quite common throughout the Pacific Northwest, and pre-contact natives would have had to live with and adapt to the occurrence of repeated small and large events. Earthquakes also can often trigger devastating tsunamis, with earthquake magnitude directly affecting tsunami height, and associated damage to humans and property (Heaton and Hartzell 1987; Satake et al. 1996).

Geology

'Tsunami' is a Japanese name for a phenomenon commonly called a 'tidal wave' in English. However, tsunamis are unrelated to the tides, but are caused by a large displacement of water by some other factor. Catalysts include submarine earthquakes and volcanic eruptions, landslides and meteor impacts. On average, normal waves may have periods of approximately 10 seconds and a wave length of about 10 metres. Tsunamis have been known to have periods greater than one hour and wave length of over 100 metres (Ayre et al. 1975:93; Murty 1977). Moreover, they are able to travel great distances at speeds well over 700 kilometres per hour. One relatively recent catastrophic example was the 1960 Chilean tsunami. A massive subduction zone earthquake of magnitude 9.5 occurred off the coast of Chile, causing an immense tsunami to travel the entire Pacific Ocean until it reached the coast of Japan, 17,000 kilometres away, in approximately 10 hours, where it caused extensive damage and claimed 200 lives

(Satake et al, 1995). The primary reason that tsunamis can travel such vast distances (such as across entire oceans) at such speeds is related to the ratio between water depth and speed (Ayre et al. 1975; Murty 1977). In other words, as the water depth increases, so does the speed of the tsunami. Moreover, as the water depth decreases, the height of the tsunami increases - as it begins to slow, it grows vertically. Therefore, as a tsunami approaches land, it may appear as a fast falling, then fast rising tide. Tsunamis usually cause great degrees of erosion, stripping beaches of sand, while destroying coastal vegetation and uprooting trees. They also are capable of reaching hundreds of metres inland, destroying various coastal structures, depending on coastal topography.

A tsunami is a violent, catastrophic event. There is little warning of the oncoming disaster, as a massive surge of water suddenly appears. The effect upon coastal populations can be devastating, as many people drown, and others suffer injuries after being caught up in the violently swirling floating debris.

Cascadia Subduction Zone

The Cascadia Subduction Zone is one of the most active seismic zones in the world, and lies a few hundred kilometres west in the Pacific Ocean, just off Vancouver Island. It is where four continental plates (massive 'floating' islands of rock that make up the surface of the world) come together in a violent confrontation. Geoscientists agree that the most troubling area is where the North American plate slides on top of the Juan de Fuca plate (Atwater et al. 1995a, 1995b; Clague and Bobrowsky 1994; Clague 1995). This area is called the Cascadia Subduction Zone. Normally, the Juan de Fuca plate is moving towards the British Columbia coast at a speed of about 2-5 cm every year. However, sometimes it is blocked, building up a tremendous amount of pressure. As a result of that pressure build up, when it is eventually released, truly enormous earthquakes can occur. Present geophysical evidence (Atwater et al. 1995a; Clague and

Bobrowsky 1994) suggests the Cascadia Subduction Zone is capable of producing subduction earthquakes greater than magnitude 9 every 300-600 years.

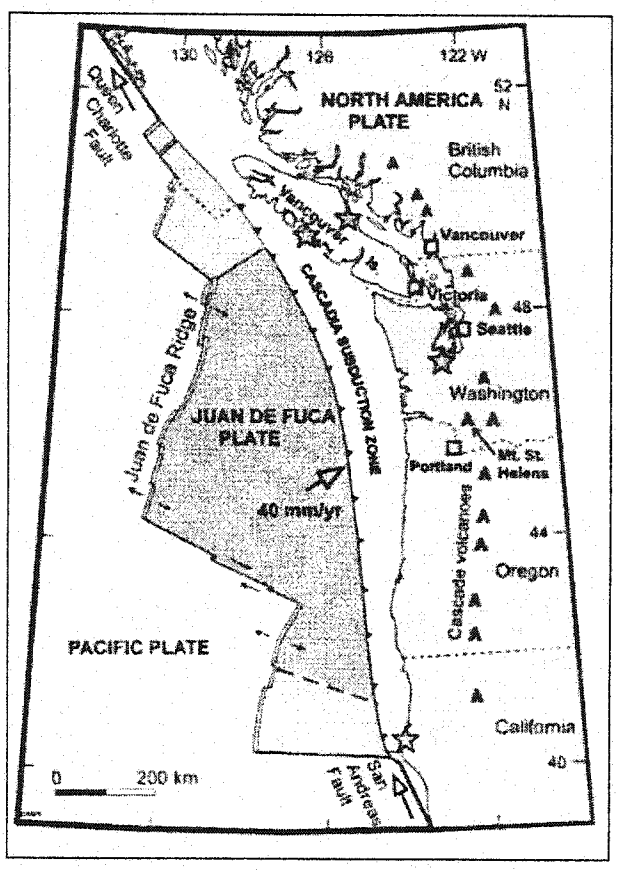


Figure 11: Map of the Cascadia Subduction Zone
(adapted from McMillan and Hutchinson 2002:45, figure 2)

Land Subsidence

Subduction Zone earthquakes produce belts of uplift and subsidence. Usually, the uplift occurs offshore over the rupture area, and the zone of subsidence includes much of the adjoining coast. This subsidence can be as much as two to three metres, as observed during the 1960 Chilean earthquake and the 1964 Alaskan earthquake (Plafker 1972). Such subsidence can cause submergence and subsequent burials of previously well vegetated coastal lowlands (Minor and Grant 1996:774). Moreover, this abrupt uplift and subsidence can be a cause of water displacement, which generates tsunamis.

Earthquakes and Tsunamis of the Pacific Northwest

Globally speaking, megathrust earthquakes occur quite rarely, as only 13 such events have been identified within the past 6,000 years, with the last one occurring in A.D.1700. The intervals between successive great earthquakes have been quite irregular, ranging anywhere from 300 to 900 years, with the average being 590 years (Geological Survey of Canada, June 2001: see internet resources). Captain George Vancouver recorded the first historically reported earthquake on the west coast of Canada in February 1793, where he wrote "a very severe shock of an earthquake had been felt at the Spanish settlement at Nootka on the west coast of Vancouver Island (Vancouver 1984). Historically, sizable earthquakes also occurred in 1946, 1949, 1964 and 1965, producing tsunamis of moderate magnitude in 1946 and 1949 (Hyndman 1996; Plafker 1972:918).

Earlier occurrences of paleoearthquakes and tsunamis can be inferred from sedimentological characteristics (such as silt layers) of deposits found beneath tidal marshes on the west coast of Vancouver Island (Benson and Clague 1997). Such deposits suggest that the most recent layer of silt was a result of the 1964 Alaskan tsunami. The next older layer was likely caused by the tsunami produced by the great Cascadia subduction zone earthquake 300 years ago. The oldest recognized layer dated between 700 b.p. and 950 b.p., resulting from either another Cascadia Subduction Zone earthquake, some previously undetermined earthquake, or a large submarine landslide (Clague and Bobrowsky 1994).

The March 27, 1964 Alaskan earthquake is one of the largest seismic events ever recorded. Because of the date, the resulting wave action has been referred to as the Good Friday tsunami (Hyndman 1995). Thus, that time, a magnitude 9.2 earthquake off the south coast of Alaska caused an enormous wave to course outwards towards the

Alaskan shore and across the Pacific. It killed over 100 people and caused nearly $100 million in damages in Alaska alone.

Analysis of Catastrophe

Evidence for similar prehistoric earthquake related land and water displacement along the Pacific coast of North America is generally difficult to obtain because the older shoreline deposits are now commonly under water, or buried beneath marine sediments (Plafker 1972:917). Also, local sea levels generally have increased dramatically throughout the Holocene (Josenhans et al. 1997), submerging evidence for earlier such displacements.

Thus, scientific evidence of the A.D.1700 tsunami has been identified only relatively recently, mainly by the Geological Survey of Canada. It must have been generated by either a single giant megathrust earthquake (magnitude 9), located in the subduction zone off the coast of Washington State and Vancouver Island, or a series of closely spaced lesser earthquakes, rupturing most of the Cascadia subduction zone (Atwater et al. 1995b). Megathrust earthquakes are also the most catastrophic type that can occur. Again, the Juan de Fuca continental plate is in the process of moving beneath the North American plate, but it is believed to presently be in a 'locked' phase. Any sudden slippage or stress release between these plates would cause a megathrust earthquake (Heaton and Hartzell 1987:165). More specifically, the thrusting motion would cause significant vertical movement on the sea floor, displacing large volumes of water and creating tsunamis.

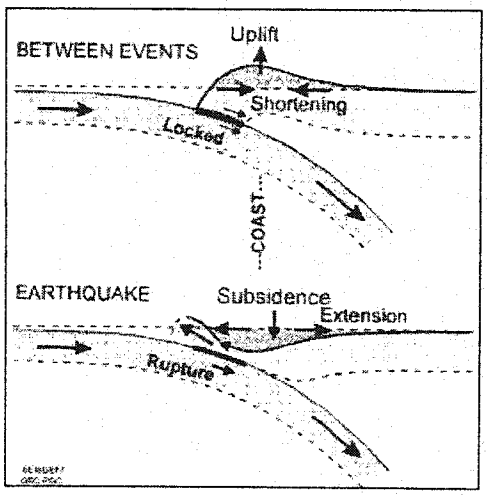


Figure 12: Continental Plate Movements (Subsidence and Uplift) of the Cascadia Subduction Zone
(Geological Survey of Canada, April 2001: see internet resources)

Theoretical modeling and preserved geological effects on the shoreline suggest that these waves may be as high as 10 metres on the open coast, and even higher in some confined inlets (Hyndman 1995:71).

Geoarchaeological Evidence

Within the relatively short span of written history of the Pacific Northwest coast, a megathrust earthquake has never been observed. However, again, there is increasing evidence that one did indeed occur about A.D.1700, just before the first European arrivals. It includes: a) buried tidal marsh indicating a sudden land subsidence of approximately one metre over a significant geographical range (Vancouver Island to Northern California), b) changes in tree ring growth (showing a drowning of roots) from coastal old growth, c) sand layers buried on top of those buried coastal marshes (driven onshore by the tsunami, d) landslide layers on the deep sea floor (caused by strong seismic shaking), and e) dated tsunami evidence from both local and distant sources. (Clague and Bobrowsky 1994).

Archaeological evidence (Hutchinson and McMillan 1997; Minor and Grant 1996) suggests that several native village sites along the coasts of Washington State and Vancouver Island were abandoned during the late Holocene, likely as a result of earthquakes and related tsunamis. Evidence from these sites, such as drowned vegetation, waterlogged twined matting and various other cultural remnants, all indicate that the most recent subsidence within the Cascadia zone occurred 300 years ago (Atwater et al.1995a; Clague 1995; Clague and Bobrowsky 1994; Minor and Grant 1996; Hutchinson and McMillan 1997; Hyndman 1995; Satake et al., 1995).

Further evidence of that earthquake comes from dendrochronological analysis and foreign written records. Thus, annual ring patterns in tree stumps on the coast of Washington State indicate that they ceased growing between A.D.1699 and A.D.1700. Detailed Japanese written records also document a tsunami doing considerable damage along Japan's east coast around the same time. After taking into consideration the time change, as well as the time it would have taken a tsunami to travel the Pacific Ocean, we can reliably date this disaster to around 9:00 PM on January 26, 1700 (Satake et al., 1996)

Native Inhabitants

Since the actual catastrophe occurred offshore, it had the potential to affect a great number of coastal populations. The longitudinal range of the earthquake (rupture) is not specifically known. If the rupture range was great, the resultant tsunamis had the potential to affect a vast area of coast, perhaps stretching from the Queen Charlotte Islands to Northern California. It would be beyond the scope of this study to attempt to search the oral traditions of all of those groups. However, an attempt was made to survey the: Haida, Nuu-chah-nulth, Cowichan, Makah, Clallam, Tseshaht, Quileute, Chinook,

Tillamook, Tolowa, and Yurok (figure 11). These particular groups were selected as they are well known and more readily observable in historical records. In addition, some of the accounts are well known to scholars, thus they were more easily located.

Oral Traditions

Accounts of tsunamis/floods and what may be earthquakes, distinct of each other, are plentiful in the oral traditions of Pacific Northwest indigenous populations. However, for reasons external to this study, oral traditions apparently recording both tsunamis/floods *and* earthquakes are extremely rare. This appears somewhat peculiar since earthquakes and tsunamis are so intimately geologically related. Moreover, precise geological sequences of catastrophic events (such as the eruption of Mount Mazama), much more complex than the simple association of the earthquake-tsunami relationship, are included/preserved in other oral traditions. Of course, there also exists the possibility that a tsunami felt here, was the result of an earthquake that occurred on the Asian side of the Pacific Ocean, or in Alaska (like the 1964 earthquake and tsunamis in Barkley Sound). This peculiarity will be addressed further in the *Discussion* section of this chapter.

The following is a collection of several First Nations oral traditions from the Pacific Northwest, arranged from North to South, that could be referring to tsunami activity (or some form of sudden destructive flooding – general sea level rises, or non-threatening sea level increases were not included). However, it is by no means exhaustive. They illustrate that these indigenous groups did indeed interact with such natural phenomena, and recorded them in their oral traditions.

A: Strong Man Who Holds Up the World (Haida)

> After the forests had failed to push back the tribe, the great *narhnorhs* who controlled the powers of the earth planned to do more mischief. They began to move the mountains down to the back of the villages and thus crowd them into the

sea. One day the people noticed that the distant hills and mountains, all in a straight row, now seemed to be drawing closer. When they moved, the ground would shake, and the villagers became frightened. The only one not concerned was the young sleeper, who paid no heed to the excitement about him, even after some of the household came in for the last time, and said, "The large village, our neighbour, has been pushed into the water, and the people have perished. Only a few have escaped in their canoes. We have made ready to escape before it overtakes us here. There is nothing more we can do now." (Barbeau 1953:323)

B: The Tsunami at Pachena Bay (Nuu-chah-nulth)

Chief Louie recorded this particular Ohiaht oral tradition at Bamfield. It is included in a larger body of historical material that was mostly collected since 1964.

This story is about the first ;Anaqtl'a or "Pachena Bay" people. It is said that they were a big band at the time of him whose name was Hayoqwis?is, 'Ten-On-Head-On-Beach'. He was the Chief; he was of the Pachena Bay tribe; he owned the Pachena Bay country. Their village site was Loht'a: they of Loht'a lived there. I think they numbered over a hundred persons. They were members of the Pachena Bay tribe.

Now it was he who did so, it is said, he who was First Chief of the Ki:x?in?ath. He performed a ceremonial woman purchase according to the native marriage procedure. He went to he whose name was Hayoqwis?is. They got in marriage the elder daughter.

The Ohiaht chief had four sons. The woman buying party set out from Ki:x?in. There were made to go through several topa:ti tests. One was broad jumping. If they jumped four fathoms they would get the girl. They were doing so on the rocky shore of Loht'a. They were jumping uphill. They were a big tribe. Those ways were big.

The woman buying party was successful. They got the girl for one of their number jumped the required four fathoms. He, the younger brother, jumped the four fathoms, but in doing so he landed on his face against the cliff, broke his head, and died. The jumping game topa:ti belonged to him who was Chief, Ten-On-Head-On-Beach. His country extended to Tloas:yo:?at and reached the point of Loht'a:. There is now no one left alive due to what this land has done at times. They had practically no way or time to try to save themselves. I think it was at nighttime that the land shook. It was a sandy beach, it is said, Ma:lts'a:s extending to Cha:hsow's. Its name was Ts'a:ts'axwach'a?aqolh, 'Place-On-Rocky-Shore-For-Spearing'. It is now called Ka:nop'al, 'Carrying-Person-On-Back'. It was floating, it is said, consisting only of sand, a house right up against the hill out of the woods, its name Satsnit, 'Place-Of-Many-Tyee-Salmon'. It was a place of many tyee salmon when they came to land from the sea. They were at Loht'a:, and they simply had no time to get hold of canoes, no time to get awake. They sank at once, were all drowned; not one survived. Only his elder daughter went to Ki:x?in as a bride from whom my former grandfather was descended.

This is it now, the Ohiahts of today. Their Chiefs are big. This is their very own history, thus the land became theirs. Now when the Ohiahts were all gone into

hiding, Chief N'a:si:smis, 'Carrying-Day-Along-Beach', of Kildonan [Ho:choqtlis?ath], it is said, went on war raids and killed of the band of Ts'axq'o:?is, killed of the band of Tl'a:ni:wa?a, and conquered as far as Tsosayi:?at. Because of that, it is said that my grandfather's domain reached Tsosayi:?at. This was brought about by the Pachena Bay Chief, brought as dowry for his elder daughter to my grandfather's ancestor before the big earthquake, before the big flood. By that my grandfather's land reached Tsosayi:?at, along with all chiefly rights, songs, topa:tis. Many are now today descended from that. Only my grandfather survived who now has many descendants. It is them now who are descendants from the first Pachena Bay people. It is said that no one ever knew what happened. I think a big wave smashed into the beach. The Pachena Bay people were lost. Their food was whale meat. That is why they were living there. Nothing was known about what happened and what became of them. But they on their part who lived at Ma:lts'a:s, 'House-Up-Against-Hill', the wave did not reach because they were on high ground. Right against a cliff were the houses on high ground at M'a:lsit, 'Coldwater Pool'. Because of that, they came out alive. They did not drift out to sea along with the others.
Everything then drifted away; everything was lost and gone. To the Chiefs of old this land was very great in their sight because they ate the drift whale that drifted on the shores of their land, also drift sea lion and everything that drifted onto their land. (Arima et al 1991:230-231)

C: (Tseshaht)

In 1868, Gilbert Malcolm Sproat published his observations about living with the indigenous populations of western Vancouver Island. Sproat stated that "The information which I give concerning their language, manners, customs and ways of life, is not from memory, but from memoranda, written with a pencil on the spot – in the hut, in the canoe, or deep in the deep forest" (Sproat 1987:xxiii). Thus, the following account appears to be first hand, told to Sproat by a Tseshaht native.

Generations ago, the Tseshaht, who live now during part of the year in Barkley Sound and the remainder of the year at Alberni, were unacquainted with the head of the inlet. They had two houses on the sound, and used to migrate from one to the other.
At that time a most curious phenomenon of nature occurred. The tide ebbed away from the shores of the sound and left it dry, and the sea itself retreated a long distance. This continued for four days, and the Tseshaht made light of the occurrence. There was one, however, Wispohahp, who, with his two brothers, did not do so. After a mature consideration of the circumstance, he thought it likely that this ebb would be succeeded by a floodtide of corresponding height and power. Accordingly, he and his brothers spent three days in the forest collecting material for a rope of cedar inner bark, which, when made, was so large as to fill four boxes. There was a rock near the village, from the base of which sprang a group of bushes, of a sort well known for its toughness. Round these bushes

> Wispohahp fastened one end of his rope, attaching the other to his canoe. In his canoe were placed all his moveables, his wife, his two brothers, and their wives; and thus prepared they waited for the result. After four days, the tide began to flow, and crept slowly up to about half way between the point of its furthest ebb and the houses. At this point, its pace was suddenly quickened, and it rushed up at fearful speed. The Tseshaht ran to their canoes. Some begged to be attached to Wispohahp's rope; but to this he would not consent, lest it should be broken. Others would have given him several of their women, but he would not receive them. They were all soon caught by the rising water; and while Wispohahp rode safely at anchor, the Tseshaht, unable to resist its force, drifted in their canoes to distant parts. Finally, the water covered the whole country...At the end of four days, the flooding began to abate. (Sproat 1987:125)

D: (Cowichan)

Cowichan traditions of a great flood and earthquake (Hill-tout 1978:157):

> ...When this raft was finished a noise like the report of a great cannon was heard and the river began to rise rapidly. There was no rain at all. As the water rose they pulled on their rope and rose with it till the top of the mountain was reached. Then the waters slackened. This condition of things lasted about one moon and then the water level began to fall, leaving the floating logs and trees on the upper part of the mountain, where they can be seen to this day. When the flood had subsided and let their raft down, again it was found that all the animals had been drowned and the fish had died; there was nothing for the people to eat but the bodies of the drowned animals or the floating fish. A great number of those saved from the flood now died from a sickness caused by eating the dead flesh. At last when the ground was dry the women and children set to work to dig wild carrots. From these they made a medicine which cured their sickness, and they recovered, and in time became a great tribe.

E: (Cowichan)

Hill-Tout also included an account within the same context as the above flood account, depicting a great earthquake:

> In the days before the white man there was a great earthquake. It began about in the middle of one night and continued about twenty hours, when it ceased. It was so severe that it made all the people sick, threw down their houses and brought great masses of rock down from the mountains. One village was completely buried beneath a landslide. It was a very terrible experience; the people could neither stand nor sit for the extreme motion of the earth. The old people took their stone pestle hammers one in each hand and pounded the ground with them, chanting a song to the spirit of the earth a they did so. They bade everybody do the same, and a little time after the shocks had ceased. "It is more than possible that these two traditions have a basis of substantial fact." (Hill-Tout 1978:158)

F: A Tsunami/Flood at Cape Flattery (Makah)

"A long time ago," said my informant, "but not at a very remote period, the water of the Pacific flowed through what is now the swamp and prairie between Waatch village and Neah Bay, making an island of Cape Flattery. The water suddenly receded, leaving Neah Bay perfectly dry. It was four days reaching its lowest ebb, and then rose again without any waves or breakers, till it had submerged the Cape, and in fact the whole country, excepting the tops of the mountains at Clayoquot. The water on its rise became very warm, and as it came up to the houses, those who had canoes put their effects in them, and floated off with the current, which set very strongly to the north. Some drifted one way, some another; and when the waters assumed their accustomed level, a portion of the tribe found themselves beyond Nootka, where their descendants now reside, and are known by the same name as the Makahs in Classet, or Kwenaitchechat. Many canoes came down in the trees and were destroyed, and numerous lives were lost. The water was four days regaining its accustomed level".

"The same tradition was related to me by the Kwilleyutes,...(and) the Chemakum. There is no doubt in my mind the truth of this tradition. The Waatch prairie shows conclusively that the water of the Pacific once flowed through it; and on cutting through the turf at any place between Neah Bay and Waatch, the whole substratum is found to be pure beach sand. In some places the turf is not more than a foot thick; at others the alluvial deposit is two or three feet."

"...there is every reason to believe that there was a gradual depression and subsequent upheaval of the earth's crust, which made the waters rise and recede as the Indians stated." (Swan 1870:57)

G: The Flood (Klallam)

There was a man who told his people to make some canoes and to make them large and strong so they could endure storms. There was a flood coming. The people said the mountains were high and they could just go up the mountains when the flood came. He warned them again. Soon it began to rain and rained for many days. And the rivers became salt. The people said they would go up the mountains. When the flood came they took their children by the hand and packed the small ones on their backs. It became so cold that the children died. They had no way of getting to the mountains for the valleys were full of water and the rivers overflowed their banks.

The people that walked all died. Those that had canoes and water and food lived. Some who were in a canoe tied themselves to a treetop when their canoe hit the tree and split. Many died. Some tied themselves to mountains and the highest ones were saved. The flood uprooted all the trees. That is why there are no really large ones left today. All the trees of today grew after the flood. (Gunther 1925:113)

H: The Thunderbird Myth (Hoh)

You know Forks prairie, Quillayute prairie, Little prairie, Beaver prairie, Tyee prairie and all the other prairies of our country. Well, these are the places where the great, elder thunderbird had terrible battles with the killer whale of the deep.

This whale was a monster destroyer of the whales that furnished oil to the children of men. It slaughtered the oil producing whales till none could be obtained for meat and oil. What were the people to do? There was no oil to drink and dip their bread and dried berries in. What were they to do! Were they to starve!

Thunderbird saw their plight and soared from her nest in yonder dark hole in the mountains. She soared far out over the placid waters and there poised herself high up in the air and waited for the "killer" to come to the surface of the water as it chased its fleeing prey. It came and as quick as a flash, the powerful bird darted and seized it in her flinty talons. Then above the watery surface she lifted it and with great effort soared away toward the land areas.

Passing beyond the oceans with her ponderous load, she, tiring, was compelled to alight and rest her wings; and each and every time the bulky beast was allowed to reach solid land there was a terrible battle; for it was powerful and fought for its life with terrible energy. In addition, each time they fought in desperate encounter, they tore all the trees up by the roots and since that time no trees have grown upon these places to this day; they have been prairies ever since. Furthermore, the great thunderbird finally carried the weighty animal to its nest in the lofty mountains, and there was the final and terrible contest fought. Here in this death struggle, they uprooted all the trees for many miles around the nest and also pulled the rocks down the great Hoh valley. Since then there has been no timber on the up-country; and the heap of debris they pulled down that valley is known as the bench; (the last terminal moraine of the Olympic glacier). Thunderbird, however, finally triumphed. It killed the beast and tore its great and mighty body to pieces; and, then, finding that it was not good to eat, it hurled the pieces from its nest in all directions, where the respective pieces turned to stone under the curse of the enraged bird. You can see them there now. They are the projecting points and rocky ridges of that high region. Before that time that section was practically level. Now you know what a broken-up rocky place it is.

That is not all. Killer whale had a son, called Subbus. So after thunderbird had killed the parent whale, it set out to capture and destroy this beast also.

This young monster was much smaller than its father, smaller on account of its not being fully developed. Nevertheless, it was more agile and wary. Consequently it took days and days of hovering over the sea before the bird of the upper sky could drop down upon it and seize it in its talons. But the unfortunate day came to it also, as it had to the parent, "killer." It was chasing a school of sperm whales and was just in the act of making an onslaught on the largest fellow of the school when there was a rustling noise and then before it could dive to the lower depths of the watery ways, it felt itself being lifted into the air, as at the same time it felt the excruciating pain caused by the huge claws of the bird being sunk deep into its body. It fought, but it was no match for its adversary.

High into the air the bird carried it over the land, finally dropping it to the land surface at Beaver prairie. Then at this place there was another great battle. Subbus was at length killed and his body torn to pieces; Moreover, its huge body damned the original channel of the Soleduck river and caused it to make the big bend to the southwestward at that place. And the huge pieces of blubber, now stone, cover the ground in the direction of its longitudinal

extension. (This is a lateral moraine of the Selkirk-Mt. Baker glacier that crosses the region here) You can see the line of rock (boulder train) there at any time.
My father (father of the medicine man who related this story to the writer) also told me that following the killing of this destroyer of the food-animals of mankind, there was a great storm and hail and flashes of lightning in the darkened, blackened sky and a great and crashing "thunder-noise" everywhere. He further stated that there were also a shaking, jumping up and trembling of the earth beneath, and a rolling up of the great waters. (Reagan 1934:36-37)

I: Tidal Wave (Tolowa)

This happened in Oregon. There were no white people on the earth when it happened. Chetko is where it happened. It is called Brookings now. Chetko or Chet is the Indian name. It is a very pretty place on the bank of the river. There are nice even fields along the river all the way down to the ocean. The rich lived near the water...
...The grandmother told the children to go right away, to go as fast as they could and not to wait for anybody. She would stay. She was too old and ready to die anyway. She told the boy to take his fish net and his money. So the boy took the fish net and the money and the two children ran as fast as they could, upstream, away from the harbor toward Mount Emilie as their grandmother had told them. Halfway there they looked back. They could hear the people cry. They could hear the cries rise and sink out. They could see the water come. When they reached the top of the mountain all the things in the woods which have names were there, deer, rattlesnake, panther, everything. The boy made a fire and sat around it. All night they sat around the fire on top of the mountain. When the sun came up it (water) had all gone away. The brother and sister stood up. Everything was gone. They went back to where their house had been. There wasn't anything there, no dead people. Everything was swept away clean. The ocean was nice and smooth. Everything was pretty. There was no wood to build a fire. The boy went down to the beach to fish. He saw far away someone coming toward him. It was a girl. He went to meet her. They got married and people started again. (Dubois 1932:261)

J: How the Prairie Became and Ocean (Yurok)

From 1900 to 1907, Alfred Kroeber performed fieldwork amongst the Yurok, traditionally located in north coastal California. During that time, one of his informants, Ann of Espeu, recited an oral tradition entitled "How the Prairie Became an Ocean". The following are relevant excerpts from the rather lengthy account.

...Then he (Earthquake) started and arrived there, at Pulekuk, he and his companion. And they arrived and he thought, "I will try. Look at this. Here it is easy" – speaking to his companion – "it will be easy for me to do that, to sink this prairie. So I shall do that first," said Earthquake. And he said "Very well." So he ran about a little and the ground sank, there at Pulekuk.

> And then they started for Opis, which is at the end of the water. That is where he did it, making the ground sink as a means of letting the water out: at the end of the water, there he did that, making the ground sink..."Now let us go, let us go to Perwerhkuk..."said Earthquake. So they came to Perwerhkuk (and) had partly sunk the ground, Earthquake had.
> ...And then from there they went south. They said "We shall have to go there: we two shall go together." They went south first and sank the ground. They were still together, those that (later) went back into the mountains. So they (two) sent south with one another. And then he did that. He repeatedly caused the ground to sink in the south. He kept sinking it: every little while there would be an earthquake, then another earthquake, and another earthquake: that is what he was doing. And then the water would fill those (depressed) places...
> ...Then they went north together and did the same: they kept sinking the ground. The earth would quake and quake again and quake again. And the water was flowing all over. (Kroeber 1976:461-465)

The following stories were recorded by Albert B. Reagan between 1905 and 1909 while he was the government agent for the Quileute and Hoh peoples. The titles used for these particular oral traditions are not native. They were by that author for the "convenience of those who may use this material" (Reagan and Walters 1933:297).

K: Thunderbird Captures a Whale

> Thunderbird lives in the sky. He makes the lightning by his rapid flight through the air. He makes the big noise by the flapping of his wings. He eats whale for food. One time Thunderbird got a big whale in his talons and carried him to Beaver Prairie and ate him there. The whale fought very hard before he was killed. Thunderbird and whale fought so hard that they pulled up all the trees there by their roots. And no trees have ever grown in that place again. (Reagan and Walters 1933:320)

L: Thunderbird Fights Mimlos-Whale

> There was a great flood. At that time, Thunderbird fought with Mimlos-whale. The battle lasted a long time. For a long time the battle was undecided. Thunderbird in the air could not whip Mimlos-whale in the water. Thunderbird would seize Mimlos-whale in his talons and try to carry Mimlos-whale to his nest in the mountains. Mimlos-whale would get away. Again Thunderbird would seize him. Again Mimlos-whale would escape. The battle between them was terrible. The noise that Thunderbird made when he flapped his wings shook the mountains. They stripped the timber there. They tore the trees out by their roots. Then Mimlos-whale got away. Again Thunderbird caught Mimlos-whale. Again they fought a terrible battle in another place. All the trees were torn out by their roots. Again Mimlos-whale escaped.
> Many times they fought thus. Each time Thunderbird caught Mimlos-whale there was a terrible battle, and all the trees in that place were uprooted. At last Mimlos-whale escaped to the deep ocean, and Thunderbird gave up the fight. That is why

the killer whale still lives in the ocean today. In those places where Thunderbird and Mimlos-whale fought, to this day, no trees grow. Those places are the prairies on the Olympic Peninsula today. (Reagan and Walters 1933:320-321).

Of the above accounts, the one that appears to best describe a tsunami occurrence, and arguably the most well known, is A: "The Tsunami at Pachena Bay". Therefore, it is this account that will be analyzed in a qualitative table format. Again, significant passages and phrases from the native account are presented in the first column, which is matched to appropriate scientific evidence in the second column.

Comparative Analysis

	Native Oral Account	**Geological/Archaeological Account**
Pre-Event	...It is said that they were a big band...Their village site was Loht'a...I think they numbered over a hundred persons....on the rocky shore of Loht'a.	There is abundant evidence of villages along the west coast of Vancouver Island during the late Holocene (Hutchinson and McMillan 1997). These villages could have sustained over one hundred people.
	...There is now no one left alive due to what this land has done at times. They had practically no way or time to try to save themselves. I think that it was a nighttime that the land shook. It was a sandy beach, it is said...Its name was ... 'Place-On-Rocky-Shore-For-Spearing'	Reference is made to past earthquakes and/or tsunamis and the devastating impact that they have sometimes had on the indigenous population. Implies that the earthquake occurred extremely fast and at night. Both these aspects are verified by geoarchaeological evidence, which indicates that a megathrust earthquake occurred in the area at approximately 9:00 pm (Satake et al., 1996). Moreover, a rocky shore with a sandy beach is an appropriate description of the physical environment of the west coast of Vancouver Island, where this particular native group was located.

During Event	...It was floating, it is said, consisting only of sand, a house right up against a hill out of the woods, its name ... 'Place-OF-Many-Tyee-Salmon'. It was a place of many tyee salmon when they came to land from the sea.		Perhaps this is a description of a hunting/fishing house or camp. A house located at a higher elevation, near an area where salmon fishing was abundant. It is also possible that the 'floating' refers to liquification of sand that can occur during earthquakes. Therefore, the house could float, and eventually sink, into the vibrating sand.
	...they simply had no time to get hold of canoes, no time to get awake. They sank at once, were all drowned; not one survived.		The speed, ferocity and time of the tsunami/flooding event are again stressed. Because that event is mentioned within the same context as an earthquake, we can assume that the tsunami was induced by a local earthquake. The tsunami seems to have been significant enough to drown a small village of about 100 people.
	It is said that no one ever knew what happened. I think a big wave smashed into the beach. The Pachena Bay people were lost. Their food was whale meat. Nothing was known about what happened and what became of them. But they on their part who lived at 'House-Up-Against-Hill', the wave did not reach because they were on high ground. Right against a cliff were the houses on high ground at 'Coldwater Pool'. Because of that, they came out alive. They did not drift out to sea along with the others.		A subduction zone earthquake would have caused a tsunami of immense proportions to crash onshore, likely extending far inland. It particularly would have rushed up any inlets or rivers as well, with the height of the wave increasing as the inlets narrowed. Such a wave would have had a caused materials and debris to drift out into the ocean.
Post-Event	Everything then drifted away; everything was lost and gone. To the Chiefs of old this land was very great in their sight because they ate the drift whale that drifted on the shores of their land, also drift sea lion and everything that drifted onto their land.		Also common in tsunamis of such magnitude is having the carcasses of dead marine life washing ashore. This is simply a consequence of the carnage caused by the devastating earthquake and tsunami.
Post-Event Adaptation	None.		

Table 4: Descriptive Comparison of Geological Evidence and the "Tsunami at Pachena Bay" Oral Tradition.

From the collection of stories contained in the *Oral Traditions* section of this study, there are several passages and references that may relate to the occurrence of the great tsunami (and earthquake) in A.D.1700. The following is simply a descriptive display of those references:

a) They had practically no way or time to try to save themselves (B)
b) I think it was at night time that the land shook (B)
c) ...they simply had no time to get hold of canoes, no time to get awake. (B)
d) They sank at once, were all drowned; not one survived. (B)
e) This was brought about by the Pachena Bay Chief, brought as dowry for his elder daughter to my grandfather's ancestor before the big earthquake, before the big flood. (B)
f) I think a big wave smashed into the beach. (B)
g) "A long time ago," said my informant, "but not at a very remote period, the water of the Pacific flowed through what is now the swamp and prairie..." (E)
h) The water suddenly receded, leaving Neah Bay perfectly dry. It was four days reaching its lowest ebb, and then rose again without any waves or breakers.. (E)
i) The water on its rise became very warm,... (E)
j) The large village, our neighbour, has been pushed into the water, and the people have perished. (A)
k) a noise like the report of a great cannon was heard and the river began to rise rapidly. There was no rain at all. (D)**
l) In the days before the white man there was a great earthquake. It began about in the middle of one night and continued about twenty hours, when it ceased. It was so severe that it made all the people sick, threw down their houses and brought great masses of rock down from the mountains. (E)**
m) The tide ebbed away from the shores of the sound and left it dry, and the sea itself retreated a long distance. (C)
n) the tide began to flow, and crept slowly up to about half way between the point of its furthest ebb and the houses. At this point, its pace was suddenly quickened, and it rushed up at fearful speed. (C)
o) He repeatedly caused the ground to sink in the south. He kept sinking it: every little while there would be an earthquake, then another earthquake, and another earthquake: that is what he was doing. And then the water would fill those (depressed) places... (G)
p) ...Then they went north together and did the same: they kept sinking the ground. The earth would quake and quake again and quake again. And the water was flowing all over. (G)
q) And the rivers became salt. (F)
r) Some who were in a canoe tied themselves to a treetop when their canoe hit the tree and split. Many died. (F)
s) The flood uprooted all the trees. (F)
t) Halfway there they looked back. They could hear the people cry. They could hear the cries rise and sink out. They could see the water come. (H)

u) Everything was gone. They went back to where their house had been. There wasn't anything there, no dead people. Everything was swept away clean. The ocean was nice and smooth. Everything was pretty. (H)
v) a great and crashing 'thunder-noise' everywhere...There was also a great shaking, jumping up and trembling of the earth beneath, and a rolling up of the great waters. (G)
w) Thunderbird and whale fought so hard that they pulled up all the trees there by their roots. And no trees have ever grown in that place again. (K)
x) The battle between them was terrible. The noise that Thunderbird made when he flapped his wings shook the mountains. They stripped the timber there. They tore the trees out by their roots. (L)
y) Again they fought a terrible battle in another place. All the trees were torn out by their roots. (L)
z) Many times they fought thus. Each time Thunderbird caught Mimlos-whale there was a terrible battle, and all the trees in that place were uprooted. (L)
aa) That is why the killer whale still lives in the ocean today. In those places where Thunderbird and Mimlos-whale fought, to this day, no trees grow. Those places are the prairies on the Olympic Peninsula today. (L)

**denotes a description of a great earthquake within a larger context of a flooding/tsunami event

Table 5: Descriptive Passages of Possible Tsunami Activity Resulting from the A.D.1700. Cascadia Subduction Zone Megathrust Earthquake

In addition to these and other accounts of earthquakes and tsunamis, many 'earthquake' masks were used in the ceremonies and rituals of the First Nations (McMillan and Hutchinson 2002). The use of such costumes during sacred times further suggests an intimate relationship with earthquake and earthquake related events. References to earthquakes are also seen in carvings and paintings as well, particularly among inland groups in the Pacific Northwest.

Discussion

As forementioned, there are numerous accounts of floods or flooding events within the oral traditions of the First Nations of the Pacific Northwest. Moreover, these accounts/stories were often considered as commodities, having ownership labels placed upon them, and therefore traded over large distances and displayed, similar to other

crests and wealth goods. Thus, it is inevitable that such stories have several common thematic elements, and have a wide distribution along the coast.

Common Flood Story Elements

It is important to recognize these common elements in order to attempt to make a distinction between 'flood' and 'tsunami' events. The main distinction is that a 'flood' event may be described as something more gradual and longer lasting than a tsunami. Flooding events tend to involve gradual rises in sea levels, whereas tsunamis involve towering and crashing waves, likely with more immediate localized destruction. There are several common elements inherent in First Nations 'flood' accounts. First, there is the foresight of the flood, or wave (basically, any rapid or lasting sea level increase of significant magnitude). Secondly, the frantic preparation of canoes and provisions is mentioned repeatedly. Another common element is the tying of the canoe(s) to the mountaintops. Several stories include this characteristic, in addition to the water level rising so high that only the mountain peaks remained dry. Hence, those that were able to tie their canoes to the mountaintops usually survived. Some accounts go on to state that there is evidence of past human habitation on those mountaintops. The death of many people is also a typical element of such accounts. Finally, the break-up and dispersal of a previously coherent group, as a result of fleeing the flood, is another common characteristic. The following are excerpts from Haida and Quileute accounts of a flood event. They serve as typical examples of such First Nations oral traditions.

> The Flood (Haida)
>
> ...Meanwhile the stranger would sit down; and when the tide would come up to her, she would move away to higher ground, up the hillside, up the mountain. Many people had saved themselves by climbing onto the raft, hundreds and hundreds of them. There were a number of rafts afloat. The whole island now was covered by the sea, and the survivors kept drifting about without being able to stop anywhere; they had no anchor. And this lasted for a long time. By and by the

people beheld peaks sticking out of the ocean. One of the rafts drifted with its load to a point where its survivors stepped off on to the land. And other rafts were beached elsewhere. It was at that time that the tribes became dispersed. (Barbeau 1953:185)

Thunderbird Causes a Flood (Quileute)

Thunderbird was very angry at one time. He caused the ocean to rise. When the water began to cover things, the Quileute got into their boats. The waters rose for four days. They rose until the very tops of the mountains were covered with water. The Quileute in their boats sailed wherever the winds and currents carried them. They had no way to direct themselves. There was no sun. There was no land. For four days the water receded. But now the people were much scattered. When they reached land, some of the people were at Hoh; so they lived there from that time on. Others landed at Chemakum and stayed there. Only a few succeeded in finding their way back to Quileute. (Reagan and Walters 1933:322)

Common Tsunami Elements

Some of the accounts (a-aa) exhibit a number of elements that seem clearly suggestive of tsunami activity. They include the presence of salt water up rivers, earthquakes, canoes striking trees, destruction caused by the ferocity of the water, low water preceding a large wave/flood, dead sea animals/life, floating debris/wood, uprooted trees, depression and bulging of ground surface, and widespread destruction (especially longitudinal).

Interpretation

After a review of those flood/tsunami accounts, as a group, they do suggest that megathrust/subduction zone earthquakes and related tsunami events are represented in the oral traditions of the First Nations of the Pacific Northwest. Tables 4 and 5 indicate that there appear to be some correlations between the geological/archaeological record and oral traditions about the same (type of) event.

A primary element that may indicate this relationship is whether a tsunami (or a flooding incident) is described within the same context as an earthquake within an oral

tradition (but not necessary, as a tsunami could be caused by distant earthquakes not actually felt in the area impacted by the wave). There is mention of 'ground shaking' and 'rolling waters' within the same sentence of an account (Reagan 1934:37). Moreover, the Yurok describe earthquakes, followed by ground depressions and the subsequent filling of those depressions with water (Kroeber 1976). They also describe this activity happening in different areas successively, in a longitudinal context. The Cape Flattery account states that strong currents soon followed receding waters, which is highly indicative of tsunamis (Clague 1995). Finally, it appears that some of the oral traditions are set in the historical (or not-so-distant) period and not the mythical one: "a long time ago but not at a very remote period" (Swan 1870:57). Therefore, it appears quite clear that indigenous populations residing in the Pacific Northwest remembered interactions with recent earthquake induced tsunamis, and recorded them in their oral traditions.

The question now becomes whether or not any of these accounts can be related specifically to the great tsunami of A.D.1700. The answer is 'not definitively'. It can be inferred that this group of stories is referring to a subduction zone earthquake that caused a great tsunami, one that adversely affected coastal populations. And since the largest and most recent such event occurred in A.D.1700, it would seem the likely choice. However, the geological sequence of events that would produce this tsunami is not unique enough to separate it from other, earlier earthquake induced tsunamis. Despite the presence of the distinct elements mentioned above, the task of relating an oral tradition to a specific tsunami event is a difficult one.

Some oral traditions have descriptions of specific environmental events, such as in the "Hoh version of the Thunderbird Myth" (Reagan 1934), that appear to be 'extra additions' attached later to the end of some larger story. Also, in the "Tsunami at Pachena Bay", there seems to be a major break in the account. This is either the result of an addition, or the combination of two originally different stories - both classic

characteristics of oral traditions. Information is always added or remodeled as time progresses and further events occur.

The megathrust earthquake and subsequent tsunami of A.D.1700 would undoubtedly have been significant enough to enter the oral traditions of many Pacific Northwest native groups. In particular, coastal populations would have been directly affected by a sudden subsidence of the shoreline, with the forms of bays, spits and deltas rapidly altered. Also, abrupt changes in shoreline elevation may have upset the equilibrium of certain marine and littoral resources on which the coastal populations were dependent (Hutchinson and McMillan 1997; Minor and Grant 1996). Therefore, given the recent age of this event, one would expect there to be an abundance of relatively detailed accounts. But this is not the case. Because this event happened just before European settlement, perhaps it was just in the process of establishing itself in the inventory of oral traditions. Then, before it could be passed on, epidemics of post-contact diseases wiped out much of the native population. This may explain the existence of relatively complex information about older geomorphological processes, like volcanic eruptions and landslides, but not about the much more recent and seemingly obvious earthquake/tsunami of A.D.1700. It happened only 2-3 generations before more than 80% of the native population was decimated by European epidemics. Therefore, this information would not have had much chance to be remembered, copied, borrowed, bought and sold like those older oral traditions about the Origin of Crater Lake and the Bridge of the Gods.

CONCLUSION

The objective of this study was to examine possible relationships between scientifically documented catastrophic paleoenvironmental events and native oral traditions. More specifically, are such events generally represented in First Nations oral traditions, and is it possible to determine whether a *specific* geological paleoenvironmental event is represented in a specific oral tradition? Unquestionably, the indigenous populations of the Pacific Northwest, in more than 10,000 years of occupation, must have endured and adapted to many volcanic eruptions, landslides, earthquakes, tsunamis, etc. Experiences with such events presumably were recorded in their oral traditions, to be passed down through generations. What is the state of such information surviving today and is it recognizable to the western scientist? These questions can begin to be answered with the results of this study. Moreover, this study has attempted to understand 'how' such information is transcribed and transmitted through oral traditions, and how it compares to the western scientific understanding of those same events. The case studies show that similarities do exist between the two paradigms, regardless of the age of the event.

First Nations people were/are intimately familiar with their environment. Drastic changes in that environment had profound impacts on them, even perhaps altering their collective mindset. Critical to that mindset was the oral transferring of information from one generation to the next. Such information could consist of moral teachings, subsistence strategies and technologies, personal family histories, learned experiences, etc. The First Nations must have learned many lessons from the environment, which were passed down in oral traditions. Those included the power that the environment can exhibit, often explained in the context of the supernatural. If an environmental event

became viewed as part of the supernatural world, then that would suggest it was significant enough to deeply affect native epistemology.

Above all else, oral traditions served as moral 'lessons', dictating ways to live and illustrating the consequences of doing right and wrong. Again, an actual witnessed catastrophic event that is entered into the oral traditions must have been seen as highly significant, symbolizing and illustrating their intimate relationship with the environment. Such an event would never be described on its own. Instead, it was always viewed contextually, as part of a greater story, usually including the supernatural or divine. Therefore, the described event is not necessarily the essence of the story, but only the 'dressing', showing the 'power' of the divine. Sometimes, such events also are tacked on to the end of mythical tales deeply rooted in moral philosophy, perhaps qualifying the story in an 'evidentiary' manner. Eventually, over successive generations, the witnessed event may become fully integrated with the moral philosophy, giving the appearance that it only is part of the metaphoric tale, with no basis in scientific fact.

However, it can be suggested that some equilibrium is reached, where description and meaning (of the event, not of the overall oral tradition) no longer change, in the same manner that the overall moral message becomes somewhat fixed. There is a belief that oral traditions cannot accurately preserve detailed witnessed information past 500 years (e.g. Vansina 1985, and others). If so, how does one explain the clear similarities between geological evidence and oral accounts of paleoenvironmental events that are thousands of years old, such as the eruption of Mount Mazama, or the Bonneville/Cascade Landslide? Some academics believe that natives were very good geologists and were able to mentally reconstruct past events by studying the topographic and geological evidence. However, that does not explain how natives would have been able to explain complex geological processes centuries before geology established itself as a discipline. Geology also struggled for many decades attempting to determine the

exact processes involved in such events as the Mount Mazama eruption and the Bonneville/Cascade landslide. In contrast, the First Nations have been telling their own versions of those stories for generations.

Moreover, the devastating effects that 18th and 19th century European diseases had on the indigenous populations of the Pacific Northwest also need to be considered. As outlined previously, that is probably the main reason why much more recent catastrophic environmental events seem very poorly represented in oral tradition. The megathrust earthquake/tsunami that occurred in A.D.1700 happened just a few generations prior to the import of European diseases, which ultimately killed more than 80% of the native population. Therefore, vital information would have had less opportunity to be copied, mimicked, borrowed, bought and/or sold – i.e. passed down to later survivors – like those older oral traditions about the Origin of Crater Lake and the Bridge of the Gods.

Another question that often arises in the interpretation of oral traditions (and seen in this study) is where does folklore/fairy tales/imaginative creativity end, and 'real' oral history begin? The answer is that no such distinction can readily be made because all such 'information' is intertwined equally as part of a coherent whole within an oral tradition. Occasionally, however, parts of an oral tradition will appear to be 'recent' additions. This is most evident when time sensitive information is added, because an oral tradition achieves fluency over time (e.g. some oral traditions associated with the A.D.1700 earthquake and tsunami). However, eventually, such information also becomes incorporated into the overall story originally contained in that oral tradition. It can be very difficult, and sometimes inappropriate, for a western scholar to simply dissect an oral tradition, without attempting to understand all the processes involved in its formation.

A difficulty also lies in the interpretation of such knowledge from a western scientific perspective. Familiarity with the creation, structure and transmission of oral

traditions must be evident on the part of the scholar. Recognizing the ways in which different kinds of information manifest themselves within oral traditions is vital in attempting to understand their meaning and context. For instance, the sequencing and uniqueness of events are paramount in determining whether an oral tradition is depicting a specific event versus a general class of events. Thus, the collapse of Mount Mazama (rather than the original explosion) is seen as a unique event. The tsunami of A.D.1700, as great a magnitude as it was, did not exhibit any particularly unique effects, as the latest of a chain of similar events that stretch far back into the past. Therefore, it is difficult to say with any assurance that certain stories depicting tsunamis are referring to the specific A.D.1700 event, or some earlier equivalent event. Additionally, understanding essential elements of oral traditions, such as metaphor, past/present components, 'apparent' and 'intended' meanings, and layered information are also critical in their correct interpretation.

The scholar should also be aware of the temporal framework in which a story is said to have taken place. Again, many oral traditions are set in different eras, such as a 'mythic' time, or what can be referred to as a 'not so distant' era. Some of the traditions referring to that A.D.1700 earthquake/tsunami event are clearly set in a more recent time, as opposed to the stories about the origin of Crater Lake, which are placed in an ancient past. Eells (1878:70) wrote that "the Clallams, ... also have a tradition of a flood, but some of them believe that it is not very long ago, perhaps not more than three or four generations since." As described earlier, Swan (1870:57) included an account that stated "A long time ago, ... but not at a very remote period, the water of the Pacific flowed through what is now the swamp and prairie ...". Chief Lalek in 1865 recounted the origin of Crater Lake, beginning with "A long time ago, so long that you cannot count it ..." (Clark 1953:53), giving the impression that while it was ancient, it was not situated at the time of creation. Therefore, if the description of the timing of the event (within the oral tradition)

coincides with geological perceptions, then the overall correlation between these two 'accounts' is strengthened.

Stories are constantly added to and remodeled as they travel throughout successive generations. Eventually, some stories incorporate European themes and elements. For example, the story of the Bridge of the Gods has several different versions. White explorers, settlers, etc., incorrectly recorded some versions, due to subtle errors in translation. Yet, at least one later account, told by a native, included such a translation error (Clark 1953:88). Moreover, stories (and information contained within them) were traded, borrowed and mimicked. As seen among the several accounts about the A.D.1700 earthquake/tsunami, there appears to be many shared elements between different groups. A good example of this phenomenon is seen in the oral traditions of the Haida. The Haida of the Queen Charlotte Islands have some accounts of interaction with glacial surges of the Little Ice Age, even though their island home has no glaciers. Such information must have been borrowed or 'bought' from their neighbours, the Tlingit, who had frequent interactions with mainland Neoglacial advances and retreats. Northwest Coast peoples formally exchanged – i.e. 'bought' and 'sold' stories or gave them away as gifts – in potlatches, or other ceremonies, like all of their other possessions.

Without such knowledge about the oral traditions on the part of the western scholar, it would be very difficult for them to distinguish between native stories that may have originally been created for entertainment, and those that have some 'real' historical basis (Fladmark 1986:10-12). There also does not appear to be any sort of 'code' that needs deciphering, or that replicates itself throughout different oral traditions. Of course, there is some patterning that is a result of borrowing and exchanging of information, reflecting the intimacy of various groups (spatial proximity). For instance, the widespread native use of the number four, which was of ritual use in the Pacific Northwest (as well as other areas of North America), likely resulted in noteworthy events being depicted in such

intervals (McMillan and Hutchinson 2002). Instead, the extent of the information contained within oral traditions seems mostly layered and contextual. No 'universal framework' or 'key' is applicable to the interpretation of all oral traditions. Rather, a knowledge of the intricacies and theoretical constitutions of oral traditions, in general, is required. In other words, the unwary scientist should not expect to easily interpret, understand or elucidate information pertinent to their needs, without first acquiring this knowledge.

An interesting outcome of this study is that there does not appear to be a direct lineal correlation between 'historical accuracy' and date of occurrence of the catastrophic event recorded by oral traditions. Thus, the correlation between the Mazama account (6850 b.p.) and the geological record, seems the same if not stronger than the Bonneville/Cascade and A.D.1700 earthquake/tsunami accounts. How can this be explained? The complete answer may lie outside the focus of this study, however, a brief statement is appropriate. As mentioned, the climactic eruption of Mt. Mazama was definitely the most unique (and oldest) event of the three case studies. Therefore, it more easily allowed for specific correlations between native and western scientific accounts. Secondly, in an oral tradition, environmental information should achieve a state of permanence, similar to the moral content, allowing its transmission without further change over long periods of time. Again, perhaps, as a result of the devastating diseases and epidemics of the 18th and 19th centuries, environmental information associated with the A.D.1700 tsunami was unable to achieve that state of permanence. Again, this may explain why an oral tradition of great antiquity seems to have a stronger correlation with geological evidence than one of a much more recent age.

There also appears to be a correlation between the number of traditions and the age of the event, with more recent events having more apparently related oral traditions. This seems like a contradiction – given that historical accuracy is not related to the time of

the event. There are undoubtedly some interesting processes at work here, and further research in this regard is needed.

Each group's oral traditions were searched based on their 'historic' location. Therefore, the depiction of a specific event in an oral tradition (as in the case of the Mt. Mazama climactic eruption) would strengthen the argument for that native group having a long occupation with that land. Thus, further study in this area may prove to be important in First Nations land claims issues.

Since research in this subject in North America is still at its inception, the information contained within an oral tradition is presently open to varied interpretations. Traditional indigenous views and scientific ones in North America tend to be more opposed, than in such regions as Africa and India. Bringhurst (1999:16) states; "The Old World is wherever indigenous traditions are permitted to exist and acknowledged to have meaning. The New World is wherever such traditions are denied and a vision of human triumph is allowed to take their place". Thus, the situation in North America is unique, because its depth of written history is so short. In places such as Africa and India, there is both a long tradition of oral histories and traditions, as well as a long history of writing, which allowed for the integration of those two approaches of the past. Also, there is a much longer history of indigenous academics in those areas – i.e. someone who has grown up within the studied culture and has also learned it from an academic perspective (e.g. similar to a First Nations archaeologist). Individuals such as these have enormous potential to 'bridge' the gap between academic and indigenous perspectives.

Further Research

Of course, further research is needed to expand, strengthen and test correlations between the western scientific and native perspectives. Many other catastrophic paleoenvironmental events have occurred in the Pacific Northwest that deserve analysis in a manner similar to this study, such as the Aiyansh Lava Flow, Temlahan landslide, and Neoglacial Lake Alsek (Sutherland-Brown 1969; Clague and Rampton 1982). For instance, a useful study would be to create a complete compilation of shared elements between stories and scientifically known volcanic eruptions, landslides, tsunamis/floods (partly covered in this study), earthquakes, glacial surges and retreats, lava flows, etc. This knowledge would help in determining whether just a *kind* of event is represented in a tradition, or an actual *specific* event. There are numerous other avenues to pursue within this realm of research. For instance, by extension, are the themes evident in First Nations epistemology common among different epistemologies elsewhere in the world? Research involving correlations between oral traditions from around the world and the scientific perspective remains also relatively untouched.

Most importantly, further research is needed in interpreting oral traditions (for the purposes of more rigorous academic disciplines such as geology, archaeology and geography), using the techniques and principles of oral history studies. It is simply not enough to rely on interpretation based on 'apparent' meanings, as valuable information may be missed in the 'intended' or 'latent' content, as seen in this study.
The goal of such research should be to develop rich and sensitive interpretations of the past, and not one 'true' past. That also essentially is the primary goal of archaeological investigation, although, it is often overlooked.

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