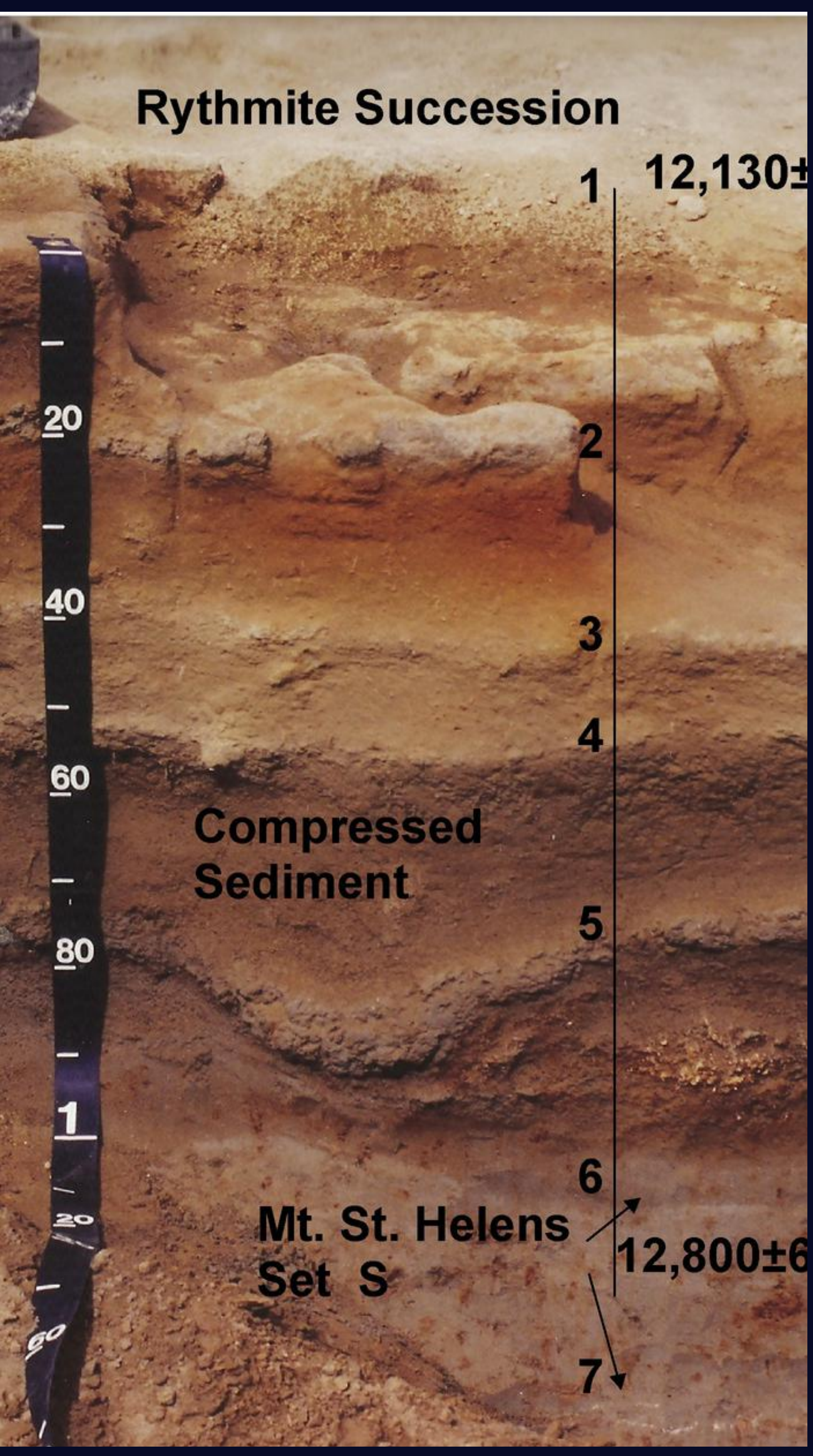

# COLONIZER GEOARCHAEOLOGY OF THE PACIFIC NORTHWEST REGION

A Dissertation

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# COLONIZER GEOARCHAEOLOGY OF THE PACIFIC NORTHWEST REGION, NORTH AMERICA

**Thesis submitted for the degree of**
**Doctor of Philosophy**
**at the University of Leicester**

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**Department of Archaeology and Ancient History**
**University of Leicester**

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**DEDICATION**

**This work is dedicated to Garreck, Haydn and Carver.**

**And to Hank, for teaching me how rivers form.**

**Abstract**

This dissertation involves the development of a geologic framework applied to upper Pleistocene and earliest Holocene archaeological site discovery. It is argued that efforts to identify colonizer archaeological sites require knowledge of geologic processes, Quaternary stratigraphic detail and an understanding of basic soil science principles. An overview of Quaternary geologic deposits based on previous work in the region is presented. This is augmented by original research which presents a new, proposed regional pedostratigraphic framework, a new source of lithic raw material, the Beezley chalcedony, and details of a new cache of lithic tools with Paleoindian affinities made from this previously undescribed stone source.

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Due to a variety of factors, but mostly my own foibles, the research leading to this dissertation has taken place over a protracted period of time, and as a result, different stages of my personal development are likely reflected in it. The first archaeological site I worked on was Richey, exactly 20 years ago, today. This was an eye-opening experience and not a bad way to become immersed in the excitement of discovery as well as the political aspects of archaeological research. For the opportunity to participate in this work, and for the support to work on a variety of Paleoindian sites across the country, I am deeply indebted to Dr. Michael Gramly. Drs. James Adovasio and Olga Soffer provided similar experiences with Paleolithic archaeology—though none of them nearly as comfortable—in the central Russian Plain. To them I owe an incredible debt of gratitude for incidents that are seared into my memory in only the way that multiple field seasons in Ukraine can be.

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## TOWARD AN UNDERSTANDING OF INITIAL HUMAN COLONIZATION OF THE PLEISTOCENE PACIFIC NORTHWEST

### Introduction

Charles Sternberg, in 1903 was the first person to record observations on the potential antiquity of man in the Pacific Northwest Region. His search for fossils of extinct megafauna in the eastern portion of the Columbia Plateau began in 1878, fueled by reports of the recovery of an intact specimen of *Elephas Columbi* from a spring in the Pine Creek drainage of eastern Whitman County, Washington state. After hearing credible accounts of fossil collections in the area, Sternberg assembled a research expedition and spent several months between January and April, 1878 excavating at a similar spring on Pine Creek. Ultimately, Sternberg was disappointed to recover only Buffalo bones (non-specific in his text, so assumed to be *Bison bison* rather than the extinct *Bison antiquus*) and an associated "flint arrowhead". Before he abandoned his search and left the area, he observed another nearby excavation where local farmers had recovered nine Mammoth specimens, a "flint spear-point" just overlying the mammoth, buffalo, deer and bird bones, and "charred and partly petrified wood that bore the marks of tools". Most importantly, he noted that the stratigraphic setting of all the finds was repeated consistently throughout the area in three distinct layers; 1. a surface cap of peat underlain by 2. clay-rich yellow sediment with 3. a base of gravel, the deepest layer containing the fossil specimens.

A half century later in 1927, Kirk Bryan had a similarly disappointing experience in the Palouse subregion (Bryan 1927). And while his search for extinct animals was actually fruitful, he left the area with the same impression as Sternberg but also lacking hard evidence; that the association of extinct animals with early man in the Pacific Northwest region would be forthcoming.

Despite evidence provided by artifact collectors of the time, these early reports of the co-occurrence of extinct megafauna with archaeological material were ultimately unproven by both researchers: even so, they predated (one by 50 years) the announcement of the Folsom find in New Mexico, and of Clovis at the Dent and Blackwater Draw sites, all discoveries which have influenced the course of "Paleoindian" studies through today (Cotter 1937, 1938; Figgins 1927, 1933). It is conceivable that if Sternberg and Bryan's research had borne proof of similar association, then more attention might have been paid to the archaeology of the region, and the Pacific Northwest rather than the American Southwest may have been intensively scoured for early man sites in the decades that followed. This might have led to new discoveries which in turn might have produced a vastly different baseline understanding of the Pleistocene colonization of the Pacific Northwest and more so, of the Americas. But that scenario didn't happen, and our present understanding of the colonization and earliest prehistory in the Pacific Northwest consists of a handful of poorly dated sites and an even thinner body of theory describing who the initial colonizers of the region were, how they lived, and exactly where they fit in the overall scheme of the initial human colonization of North American.

In subsequent years, to be sure, the Pacific Northwest region has produced notable early sites of international significance, such as Richey-Roberts, Kennewick Man and the Marmes Rockshelter (Chatters 2000, 2001; Gramly 1991; Fryxell and Keel 1969).

The fact remains, however, that these important early sites exist as relative outliers in the regional cultural scheme. Their relationship to cultural development in the region is necessarily presented from the perspective of sites from other regions—East Wenatchee, within the framework of Clovis, which is in large part known from classic southwest descriptions (Haynes 1980). The deep levels at Marmes as a fascinating yet enigmatic outlier, holding some of the earliest North American human remains in a complicated rockshelter matrix, re-used through time, with diastemic separation between its initial occupation horizons and more recent early to middle Holocene archaeology. The Kennewick Man site, although compelling, and a darling of everyone from academicians to racist organizations, has only led to more confusion as litigation and political positioning, rather than empirical reason and free hypothesis testing have steered and ultimately squashed research goals there (Chatters 2001; Downey 2000; Thomas 2000). The handfuls of other early sites often suffer from incomplete or poor documentation (according to modern standards of research) and a generalized lack of peer-reviewed treatment. Of course, notable exceptions to these generalizations exist, and they are addressed specifically in Chapter 2 below.

### Pacific Northwest within the context of the broader North American colonization

Researchers agree that makers of fluted (Clovis, Folsom and other) spear points were in North America at the close of the Pleistocene, but there's not a lot of agreement regarding their ancestors. For decades the classic model of big-game hunters crossing the Bering Strait just over 11,000 years ago was considered by most people as the simplest explanation of earliest American colonization. Even so, other researchers presented arguments for pre-Clovis cultures entering North America along the Pacific or Atlantic Coasts, potentially much earlier than Clovis (Antevs 1935; Bradley and Stanford 2004; Fladmark 1979; Gruhn 1994). Both models address the initial entry of first peoples in the broadest sense; but neither address colonization in finer detail. In order to get to an understanding of when and from where people colonized the Americas, more attention should be payed to regional to local entry models based on site discovery. One way to carry out these finer scale searches is to develop landscape-based models that identify the ancient landscapes people entered. Instead of focusing on the broadest-scale trends, local to regional models of site paleoenvironments and characterization of available resources should be identified in order to search for colonizer archaeology.

### The Project Area

The Pacific Northwest is a subregion of the North American continent that lies on the Pacific Coast of North America. It is bounded by the Pacific Ocean to the west and the Rocky Mountains to the east. Portions of several U.S. states and a Canadian province are included in the region, specifically, Washington, Oregon, Idaho, western Montana, northern California, Alaska and a portion of British Columbia. Within this region, covering an area of about 260,000 square km lays the primary focus of this study, the Columbia Plateau ecoregion (Figure 1. 1; hereinafter referred to as "the Plateau"). The Plateau is bordered on the east by the Northern Rocky Mountains and on the west by the Sierra Nevada-Cascade region. The Plateau is uniformly covered with basaltic lava flows of the Miocene age Columbia River Basalt Group. Over time, Plate-teconics have warped and faulted the landscape, producing topographic variations in elevation ranging from 200 to 5,000 feet (60 to 1,500 m) above sea level. The dry-central portion of the Plateau includes a prominent, regional bedrock structural feature Raisz (1945) identified as the Olympic-Willowa Lineament (OWL). This geomorphic alignment is expressed as a zone of anticlinal ridges several tens of Kilometers wide, whose primary feature is known as the Yakima Fold Belt (Keinle et. al, 1977). Drainages across the Columbia Plateau are controlled by these structures, and initial colonizers undoubtedly referred to them as a primary way finding tool.

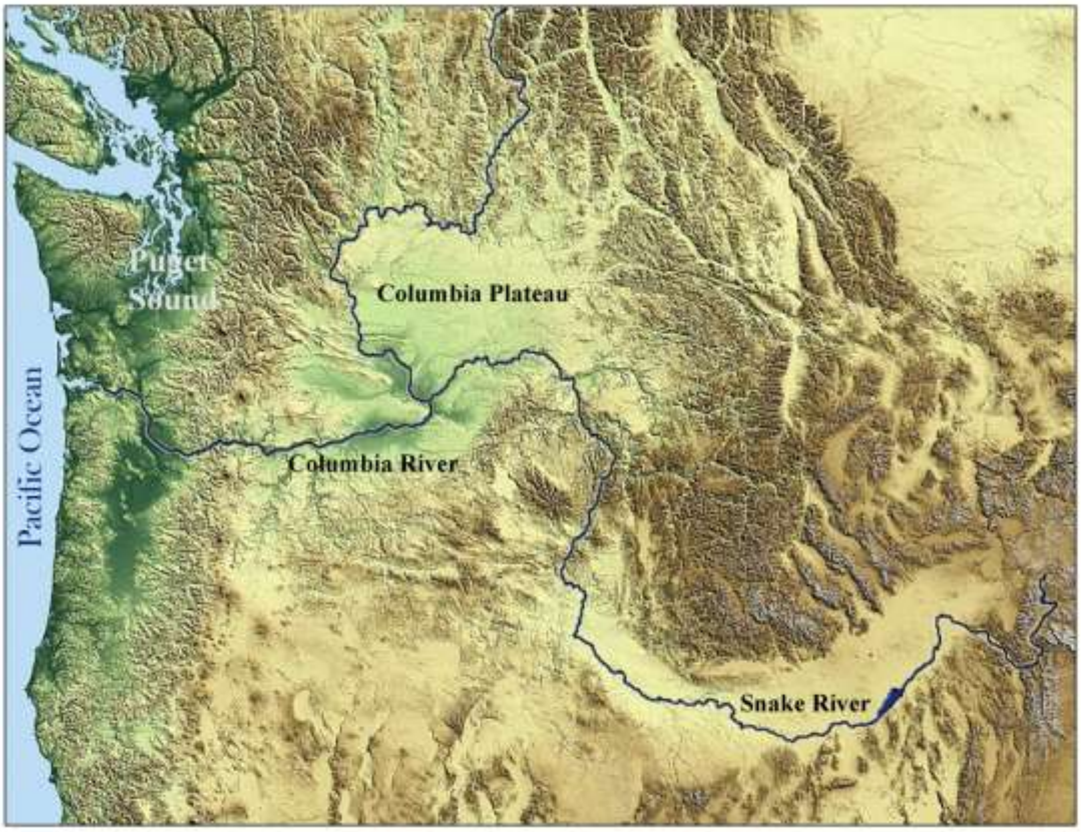


Figure 1. 1 Location of the Broad Study Area on the Western Coast of North America

The climate of the Columbia Plateau at present is semiarid; vegetation is limited mostly to shrubs and grasses. The Columbia and Snake rivers drain the region and have served as the primary locations of human concentration for the majority of the Holocene. Tributaries to these include the Yakima, Wenatchee, Okanogan and Walla Walla rivers and the Crab Creek drainage.

**Colonization**

The process of human colonization and its relationship to archaeological studies is a relatively recent avenue of research (Rockman and Steele 2003). At its most fundamental level, this dissertation is about understanding details of the upper Pleistocene landscape of the Columbia Plateau, and its relationship to the process of colonization. The ultimate goal of this research is to help steer the identification of archaeological material that is representative of the period of colonization. To address these details, it is necessary to treat colonization as a process rather than as an event, and this approach has several fundamental assumptions. 1. Colonization of any new environment is not a single stage event. It takes place at the scale of generations, rather than years or decades. 2. It is an iterative process that begins with initial forays into unfamiliar areas and is achieved when the previously unexploited landscape is incorporated into a unified adaptive resource procurement framework and m is ultimately marked by a viable reproductive population. 3. It is a process that is repeatable by multiple independent populations, each with potentially unique approaches to learning, variably affected by antecedent populations through archaeological clues (indirect cultural transmission) and via face-to-face interaction (direct cultural transmission) (*sensu* Boyd and Richerson 1985).

Colonization is not necessarily related to a conspicuous effort to overtake a landscape *per se*, rather, colonizers are interested in the process of making economic and ideological decisions that bear on their enduring a given landscape. It is ultimately a process with an end result that endows cultural attributes and assignments to geographic space, but whose fundamental goal is simply survival.

**Introduction to the Colonizer Period Concept**

For clarity, and in order to avoid confusion that might arise from intermixing terms, I propose the term *Colonizer Period* to include that period of time from the last glacial maximum to the beginning of the Younger Dryas period. This designation is purely functional—I have no intention of attempting to re-write or append the regional culture histories—they are well-defined and long-established. Rather, for the purpose of discussion within the context of this work, the colonizer period concept provides a convenient means of conceptualizing colonization as a macro-scale, attenuated or time-transgressive process, without much in the way of pre-conceived notions of cultural affiliation (i.e. Clovis, Folsom, Windust cultural traditions). It includes both initial colonizers, a presently unknown group(s) of people which must predate established archaeological cultures (see discussion below), and a number of upper-Pleistocene through earliest Holocene archaeological cultures, variously termed Paleoindian (Ames et al, 1998), Paleoarchaic, Windust (Leonhardy and Rice 1970), Early Period (Chatters and Pokotylo 1998), Early Prehistoric Period (Roll and Hackenberger 1998) and Shonitkwu (Chance and Chance 1977). I will refer to the terms colonizer and colonizer period when speaking in a generic sense, and I will refer to defined archaeological cultures when referring to specific regional studies in the archaeological literature. I've chosen to be inclusive of this broad range of early people as they either predate or are penecontemporaneous with social aggregation and regionalization which appears during the early Holocene on a continent-wide scale (Boguchi 1999). I return to this point in a short discussion of colonization below.

Archaeological evidence makes it clear that at least one group of people reached the Pacific Northwest region by 14,000 years ago. The remains of a Mastodon, likely butchered, near Sequim, Washington State and human refuse dated in the Paisley Caves in the State of Oregon are the earliest regional evidence for Colonization (Gilbert et al. 2008; Gustafson et al. 1979). Subsequent populations who made Clovis and stemmed artifacts roughly 11,000 years in age, are known from a small handful of sites across the region (Gramly 1991, Mehringer 1988). So while it is clear that colonization of the region took place across at least a 3000 year period, the process of colonization and critical detail regarding most fundamental aspects of human life ways remain unknown. Details of how the initial generations of people who explored the landscape organized and utilized its resources, the degree of their influence on subsequent occupation patterns, even how fully humans understood their environment is not well understood.

## Errors of Sampling

The relative lack of recorded Colonizer sites in the Pacific Northwest region may relate to a lack of research in sediments of appropriate age. Large-scale archaeological survey efforts have failed to identify upper-Pleistocene sites, and they remain underrepresented in the overall archaeological record of the Pacific Northwest. Understanding the methods, scope and scale of such surveys makes it clear why this is the case. Efforts by the U.S. federal government to dam the Columbia and Snake Rivers for hydroelectric power generation in the 1950s–1960s were the impetus for many large-scale archaeological projects, yet surface sediments that bound the reservoir margins are primarily Holocene in age. While dozens of relatively large and thousands of small archaeological reconnaissance efforts have been undertaken in the Columbia Plateau, the bulk of them are related to either reservoir or transportation projects, or to relatively small developments which lack the scope and scale to identify buried early sites. Upper Pleistocene and earliest Holocene sediments are often located in the uplands, away from the reservoir margins or the active coastal environment, the product of middle-Holocene geologic processes (Chapter 3 below).

The disproportionately low number of recorded Colonizer period archaeological sites is not only a result of looking in the wrong places; it is a result of the failure to target depositional environments that have potential to contain Colonizer sites. Simply put, archaeologists have looked for these early sites in the wrong places. There is a relative lack of applied subsurface methodologies to identify potentially deep, early deposits. Geomorphology and natural processes of sedimentation also play a significant role in sampling error. Colonizing groups of the upper Pleistocene to early Holocene utilized landscapes that are vastly different today than they were at the close of the ice-age. Stream valleys have undergone repeated cut and fill episodes, leaving the paleolandscape, where it is preserved, deeply buried beyond the reach of discovery by traditional archaeological survey methods. Isostatic rebound in glaciated areas, in concert with rising sea level has led to the relative isolation of Colonizer-period landforms well away from modern land-use environments that are commonly subjected to archaeological survey. Together, these factors lead us to an archaeological record in the Pacific Northwest that is heavily skewed towards the late-prehistoric period.

Similarly, large scale surveys away from the large river basins have failed to target early deposits through probing, trenching or other subsurface methods. As an example, Axton et al. (1999) surveyed >13,000 acres in the central Columbia Plateau and did not record a single prehistoric archaeological site. Speaking of problems faced during the survey, Axton et al. (1999:2.4) state,

> "Fluctuations in the reservoir level remove and deposit sediment, and the area of Upper Crab Creek is a shallow, meandering drainage. Wind and water continually erode and move unconsolidated sediment, causing constantly shifting landforms in some areas. Much of the study area is covered by volcanic ash and dense vegetation, which probably obscures some cultural remains."

Axton's target survey area is located in a reservoir setting that was a patchy mosaic environment with seasonal stands of water during the upper Pleistocene, and to a lesser extent, throughout the Holocene (see Chapter 3). It includes a flowing portion of the Crab Creek drainage, the only continuous source of water through the arid interior of the Columbia Plateau, bisecting lands between the Columbia River to the west and the Palouse subregion to the east. On the Columbia Plateau, as in other arid regions, water is the key limiting resource. In upland settings far from the predictability of Columbia or Snake River sources, where water exists, archaeology is often found.

Compounding this problem of gross sampling error is the treatment of gray literature created for regulatory compliance projects, as representative of rigorous, focused research efforts. In a broad discussion of the Paleoindian occupation of the Plateau, while explaining the low densities of Pleistocene archaeological sites, Ames (1988 and Ames et al. 1998) address the lack of Paleoindian sites and materials in the Scabland tracts. Ames bases his discussion on two reconnaissance efforts, Green (1975) and Chatters (1982) as surveys that did not deliver evidence for early people there. He states,

> "While the data are not extensive and while no one has deliberately sought out sediments of the desired age and tested them, I believe the evidence is sufficient to support the claim that the dry central plateau was not occupied during this (Paleoindian) period."

While disappointing, this conclusion is understandable as Ames was working with a tiny dataset that applied an inadequate identification strategy (called out by Ames in the first sentence of the excerpt above). The Green and Chatters surveys are disappointing in their lack of rigorous or even reasonable research methods. Reporting the methodology that led to his findings, Green (1973:10) states, "The archaeological reconnaissance was done by motor vehicle and on foot." While it is not clear whether or not the author actually means that he looked for archaeological sites while traveling in a moving vehicle, it is clear that he did not attempt a particularly rigorous effort to identify Pleistocene and early Holocene landforms that might contain similarly aged cultural deposits. Likewise, Chatter's survey was inadequate in terms of addressing the Paleoindian period. Neither did Chatters seek old sediments, nor did he conduct shovel testing to sample subsurface deposits (see Lyman, 1985 for similar criticism). To be fair, Chatter's and Green's surveys took place more than 30 years ago (the Axton survey is simply an inadequate effort). A quick analysis of the scope of work for each project makes it clear that subsurface efforts were not part of the job. Nonetheless, the results of these surveys underscore a need for rigorous subsurface protocols for development-based archaeological surveys, scaled to the overall level of effort of the research project, lest the results become part of the working body of *academic* literature, as in the case of Ames' (1988 and 1998) reports (again, I'm not criticizing Ames, he was working with the only available data at the time).

**Founding Principles of the Research Problem**

*Colonizer Visibility: Population, Timing, Toolkits and Route of Entry*
Regarding the process of colonization, it is likely that a variety of factors including random demographic and environmental events may lead to the extinction of small populations of colonizers. If these colonizers represent individual migration events or splinter groups from larger disaggregating populations, unless we find their remains and can directly study individuals within the population, they may either appear absent

from the archaeological record or remain grossly underrepresented and their archaeological signature will be essentially impossible to recognize (Lande 1988).

Researchers of colonizer archaeology should assume a significant element of adaptive plasticity. The process of learning a new landscape may require multiple generations before adaptive strategies become recognizable in the archaeological record. Before it is possible to identify colonizer archaeology—a fundamental goal of this research effort—it is first critical to be able to locate and recognize buried archaeological material that is representative of the colonization period. Several potential obstacles may stand in the way of this goal, the foremost being archaeological visibility, defined here as the potential to *intersect* a site regardless of the means (either by targeted archaeological reconnaissance or via fortuitous encounter) and once that is accomplished, to *identify* artifacts there. Stated in brief, only as the colonizing population(s) reached a viable reproductive population level, likely after a long initial colonization phase, would colonizers achieve widespread archaeological visibility (Toth 1991).

Having established the geologic visibility dilemma, I'll return to the issue of a time target. If we focus discovery efforts on the post-glacial period, which appears to be a good fit with the majority of present working hypotheses, then we face a range of time between the LGM (~20 KBP) and the earliest bona fide archaeological evidence in the Pacific Northwest (~14 KBP), a period of more than six thousand calendar years (Gilbert et al. 2008). If we focus on a pre-LGM time range, the critical problem then becomes defining an upper time boundary. Depth to horizons representative of this time range is limiting—and in many cases such as glaciated or megaflood-affected terranes—these horizons were removed completely by geologic degradation. In the interest of simplicity, it is probably reasonable to work from the present towards the past. So, the time focus of this dissertation research will be post-glacial. In doing so it will be possible to work backwards from what is known, while framing the overall focus on the late Pleistocene period. Last, even if we clearly understand where to look for colonizer archaeological sites, we truly face a needle in a haystack situation. If the future of colonizer research in the Pacific Northwest is anything like the past, Lady Luck will bring to light fascinating new data long before targeted research efforts reveal anything of note.

The archaeological record is bolstered by recent human genetic data which points to a pre-Clovis population in North America, possibly even prior to the last glacial maximum (pre-20 KBP: Merriwether, 2002; Schurr, 2004). Genetic evidence suggests multiple migrations, possibly three or more stemming from an Eastern Asian genetic stock (Derenko et al. 2001). In addition to archaeological, geologic and genetic evidence, linguistic data hints at similar timing of colonization, although confidence that linguistic evidence is reliable beyond the range of the Holocene is unclear at present (Nichols, 1990, 2002; cf. Greenberg, 1987).

*Route of Entry*

Third, for the sake of the model it is important to hypothesize a specific route of entry. Two possibilities exist; the first would be migration from the North American continental interior, the other is a coastal route. Understanding colonizer origins is important due to significant differences in baseline resources and the implications of the resource base to adaptation. Colonizers that were adapted to a land-based continental interior might utilize the landscape in drastically different ways than people with coastal-marine adaptations. The goal of the following discussion is not to re-hash long-standing arguments of macro-scale colonization routes, the likes of which have fueled debate for decades, rather, to provide a basis for testing arguments which follow in the thesis.

Understanding details of the colonization of the Columbia Plateau is inevitably tied to understanding colonization of the broader North and South American continents. This dissertation is presented from the perspective that, while models of Continental colonization may provide macro-scale theoretical underpinnings that may inform issues of process and elucidate some detail of broad archaeological trends, they fail to provide insight into regional archaeological schemes. Conversely, regional archaeological studies such as this, when appropriately focused, may play a significant role in ultimately piecing together comprehensive models of Continental colonization.

Colonization of the American hemisphere came at the end of a long, global colonization process. Somewhere between 70 to 30 KBP, with deep roots in Africa, modern humans began to spread throughout the entire Old World. It is known that by 32 KBP modern humans were present in the northern latitudes of the Siberian Arctic (Pavlov et al. 2001; Pitulko et al. 2004). Goebel (1999) reports sites of similar age from the subarctic of central Siberia and arctic Russia. From these locations, humans spread into the Arctic just prior to the LGM (Goebel 2008). Colonization of the American continents then, occurred last, following the eastward colonization trend.

*Clovis vs. Pre-Clovis Arguments as they relate to the Colonization Route*

The earliest recognized artifacts in the Americas are Clovis points. Clovis points appear in the archaeological record of North America in the relative “blink of an eye”, at least from the perspective of geologic time (within a broad range between 12.7-13.1 KBP; Waters and Stafford 2007). For decades the “Clovis First” hypothesis explained the sudden appearance of Clovis points on the landscape, as they were assumed to represent the earliest diagnostic artifact type in the Americas. Geomorphic data postulated an “Ice free” corridor between the Laurentide and Cordilleran ice sheets, a geographic zone that was essentially viewed as a Paleo-superhighway linking Clovis colonizers in Alaska with the North American heartland (Haynes, 1964). Complementing Haynes’ descriptions of the Clovis culture was the “overkill” hypothesis of Martin (1973), which suggested that on entry, Clovis hunters decimated the continental megafauna population. The “Clovis first” hypothesis was tidy and simple, and led our understanding of North American Paleoindian studies for the better portion of four decades. But research over the past decade has made it clear that, not only was the hypothesized "Ice-free" corridor "closed" at the time of initial Clovis occupation, multiple migrations of initial colonizers likely made their way into the Americas at different times (Mandryk et. al 2001).

Compounding this data and rendering the ice-free corridor hypothesis entirely moot, at least with regard to initial colonization of the Americas by east Asian progenitor(s), is the generalized acceptance by professional archaeologists of South American archaeological sites which are older than Clovis by at least 1000 years. Surovell (2003a, b) suggests that four possibilities exist to explain this discrepancy in Paleoindian space/time. (1) The age, artifacts, or stratigraphic integrity of many early South American archaeological sites are problematic. This explanation is unlikely as the South American archaeological record is based on a scientific peer-review process that is no less rigorous than that which the North American record was created by, often by North American archaeologists.  Similarly, a contingent of prominent North American archaeologists, some of which were the most staunch “Clovis first” proponents, visited one of the early sites (Monte Verde, Chile) and published a consensus opinion of its authenticity (Adovasio and Pedler 1997); (2) Humans entered South America before they entered North America, a point which would require transoceanic travel, a feat which has precedent in global colonization history (Pleistocene Australia), but that requires much in the way of luck on the part of the colonizer and is far from simple; (3) Earlier sites exist in North America but we have not yet discovered them or accepted their antiquity—a primary assumption of the present work, but that also relies on (4) The initial migration into the New World occurred rapidly from north to south via a coastal route the traces of which have been inundated by rising late Pleistocene and early Holocene Sea levels.  None of the proposed explanations should be considered mutually exclusive.

Having posited that the continental interior is not a valid *early* route of entry due to merging of the continental ice sheets and that transoceanic travel is sufficiently difficult to render it less likely than the alternatives; we are left with entry route alternative(s) along either of the American continental coastlines.  While two prominent Paleoindian specialists have recently suggested that, despite a 5000-year hiatus between Solutrean and Clovis archaeological materials, Clovis technology has a direct relationship to Solutrean culture (Stanford and Bradley 2003); this multi-millennial gap in time is far from simple to explain, both in terms of travel near the glacial maximum, and in terms of the across-the-board lack of material culture.  It is difficult to conceive of a well-established, highly-recognizable lithic industry, such as the Solutrean, nearly invisible for five millennia.

Given the goal of identifying a route of entry, in order to choose a position from among these alternatives, I prefer to invoke the meta-theoretical principle of Occam’s razor, “*entia non sunt multiplicanda praeter necessitatem*“.  This principle, translated in short, states that when competing hypotheses are equal in all other respects, one should select the hypothesis that introduces the fewest assumptions while still answering the question.  A Pacific coastal entry route provides the most parsimonious explanation to the issue of colonization of the Pacific Northwest region.  It is important to note that the earliest South American sites, even though located in the uplands, miles from the coast, have evidence for the exploitation of a wide variety of marine resources, possibly suggesting a deep connection to coastal lifeways (Dillehay et. al. 2008).  For these reasons, this work assumes a position that colonizers of the North American continent generally, and of the Pacific Northwest specifically, emanated from eastern Siberia and traveled along a Pacific coastal route.

*Material Culture*

Second, we are unsure of the nature of material culture we are looking for, which can be characterized as a subset of the overall sampling issue.  This problem of technological visibility, the ability to identify artifacts which serve as time-stratigraphic index fossils in a given assemblage, based on technological or functional attributes that are representative of a culturally-specific lithic suite, may play a significant role in colonizer site identification, depending on the nature of tool types used by colonizers. Some have proposed a “pre-projectile” tradition for the earliest colonizers (Faught and Freeman 1998).  West and Louys (2007) present Pleistocene evidence from SE Asia that may indicate the extensive utilization of bamboo in place of lithic raw material.

The Manis Mastadon has an antler artifact embedded in a vertebrae and a bone projectile is known from the Bishop site (Chapter 3; Gustafson et al. 1979; Waters et al. 2011), so it is difficult to rule out the possibility of a lithic-free colonizing culture. Although the likelihood of any society avoiding lithic tool use for any archaeologically significant length of time seems intuitively low to me, based on the vast record of Paleolithic archaeological cultures, if initial colonizers did not utilize stone tools in any formal manner, then issues of taphonomy and preservation compound the colonizer discovery process in geometric proportion. Even so, at the site of Monte Verde in Chile, which dates more than one thousand years prior to early Paleoindian sites in North America, while lithic tools do not dominate the artifact assemblage, they are present (Dillehay 1997).

Given this, it is reasonable to assume that colonizers utilized lithic tools. It is similarly reasonable to anticipate that they utilized a generalized Paleolithic technology that consisted of formal tools in the sense of Andrefsky (1998), tools that display intentional, invasive retouch suggesting that they were produced in advance of use. But as with the paradox of timing, without specific knowledge of formal tool types that would serve as diagnostic indicators of the colonizer period we still don't know exactly what we're looking for. Once again, it is reasonable to look at the simplest plausible solution for steerage. A hallmark characteristic of many Upper Paleolithic tool assemblages, certainly those of Eurasia and Siberia, is the production of prismatic blades (Bar-Yosef 2002). During the upper Pleistocene, in the eastern portion of the old world, Upper Paleolithic people carrying a blade-based technology were present in Mongolia and northern China (West 1996 and references therein; Goebel et al. 2000). It is also known that by 32 KBP modern humans were present in the Siberian Arctic utilizing a Paleolithic toolkit that includes formal tools that are not unlike those found in some Paleoindian assemblages (Pavlov et al. 2001; Pitulko et al. 2004). Goebel (1999) reports similar "classic" Paleolithic artifacts from the subarctic of central Siberia and arctic Russia. From these locations, they spread into the Arctic just prior to the LGM (Goebel et al. 2008). Goebel et al. (2000) provide solid dates for a microblade-based industry in northeast Asia, the likely homelands of American colonizers. It follows that we should anticipate the colonizer tool kit to include the presence of blades and blade-based tools. Clovis toolkits contain macroblades made from prepared cores, likely an indication of ties to these old-world lithic industries.

The archaeological record of eastern Asia and western Beringia is a reasonable place to search for ties to American colonizer lithic technologies. Between these locations it appears clear that Upper Paleolithic lithic assemblages are indeed blade-based with a transition from macroblade toward microblade production at roughly 20-18 KBP (Goebel et al. 2000). The Diuktai archaeological culture of eastern Asia contains bifacial tools and microblades and is considered a strong candidate as progenitor for colonizer cultures (Goebel et al. 2008). Another proposed cultural antecedent to American colonizers is found in the Ushki complex, comprised of bifaces and blades, with a conspicuous absence of microblades, although relatively recent dates may place the Ushki sites too late to be directly related to descendant North American colonizers (Goebel et al. 2003). The most recent, unequivocal tie between upper Paleolithic Siberians and North Americans is at Swan Point in Central Alaska, based on a microblade-based lithic industry dated to 13.6 KBP, very similar to Diuktai technology (Goebel et. al. 2008; Holmes et. al. 1998). Also in Alaska, the slightly later Nenana archaeological culture is another potential archaeological manifestation related to colonizing populations. The Nenana toolkit includes small bifaces and unifaces, but it is differentiated from earlier east Asian toolkits by the absence of microblades and burins. Once again, it is clear that the common denominator of all toolkits that might represent colonizing cultures is the production of blades through a prismatic core reduction technology.

Given the relatively generic Paleolithic toolkit, in very shallow depositional settings that are subject to bioturbation and similar post-depositional problems, we might record and collect surface manifestations of Colonizers and be completely unaware of their Colonizer origin. Archaeological material from sites that represent Colonizers undoubtedly exists in curation facilities and archaeological collections across the land, but due to lack of context and lack of understanding of diagnostic attributes of the earliest artifact types, we might never know better. Third, and probably more important than the other issues combined, is the problem of low colonizer population density that leads to overall low archaeological visibility.

**Issues of Reproductive Fitness, Mortality and Archaeological Visibility**

The prominent and conspicuous aspects of our environment guide human perception: those details that are most likely to be observed are aspects of our experience that are immediately tangible (e.g. artifacts and archaeological features; Upham 1988). Human “reality” is predicated by observation and those aspects which go un-noticed, no matter how “real” or what relative contribution they have to the subject at hand, inevitably fail to inform our observations. Within the context of our perception of the prehistoric past, these observations are critical to the development of archaeological models, and therefore, any discussion of colonization must hinge on the topic of archaeological visibility. Prehistoric archaeological cultures, however they are defined, must have reached a threshold population level before they offer potential to be recognized within the archaeological landscape. Reproductive fitness, therefore, plays a critical role in colonization studies. Chatters (in prep.) presents a compelling argument regarding the patterns of death in Paleoindians as represented by the relative few skeletons available for consideration. In all breeding populations, the reproductive fitness of males is constant: as a result, any variability among females, in particular the combined effects of gestation, breast-feeding and mortality become key factors in determining the overall reproductive fitness of colonizing groups. Given high mobility, high injury rates, variable nutrition, infant mortality, gestation and reproductive cycling due to breast-feeding, Chatters hypothesizes that early Paleoindians had very low reproductive rates. He suggests that the lifestyle of highly mobile people who likely experienced episodes of malnutrition, led to late menarche and periods of infertility. Based on Chatters analysis of Paleoindian female skeletons, the average age at death is 22 years. Small colonizing populations with low reproductive success could remain archaeologically invisible for a very long period of time. Steele et al. (1998) assumed an average population growth rate during colonization at 3%. At very low reproduction levels as hypothesized above, given the relatively late barrier presented by the Ice Free Corridor, the only viable route to colonization is along the Pacific Coast (Luis Lanata et. al 2008).

## The Purpose of a Landscape Approach?

By focusing on baseline resource availability and the physical aspects of the landscape, it is possible to steer clear of deterministic models and consider the *potential locations* of colonizer sites and look toward the end product—ultimately, an occupied landscape with obviously patterned behavior represented by redundancy in the archaeological record. This approach requires that technology is viewed as part of the human phenotype, with relatively little emphasis on functional or stylistic aspects outside of their ability to inform on the relative time scale (Clovis points vs. Stemmed points vs. no points). Similarly, by acknowledging ideological as well as economic reasons for colonizer behavior, it is possible to move beyond two dimensional models which tend to focus on timing of arrival (who was first), site distribution (their economic range) and subsistence economy (what they ate along the way), as these are topics which necessarily follow identification and primary characterization of the research target—which are initial colonizers.

Meltzer (2004) suggests that to resolve the issue of initial colonizer entry routes into the North and South American continents, we need new data from new archaeological sites. He points out that despite a recent emphasis in archaeological site discovery via targeted sediment coring, remote sensing, and sampling of the submerged landscapes along the North American Pacific coast (Fedje & Christensen, 1999; Fedje & Josenhans, 2000), no sites older than 10.5 KBP have so far been identified. And while heavy vegetation covers islands and remnant coastlines with high potential for site preservation, a simpler research approach to Colonization is to examine the coastal-proximate continental interior i.e. the Columbia Plateau, where such limitations do not exist. By focusing on details of resource availability, paleoenvironmental suitability and geoarchaeological probability, it is possible to test hypotheses of initial regional colonization of the western Cordillera and ultimately to extend that understanding to continental scale analyses.

In terms of initial colonization of the region, the Columbia River is the first major river corridor along the coast of western North America encountered by colonizers of the continent. As such, it is a likely route into the continental interior, certainly into the heart of the Columbia Plateau. Examining ecological relationships of initial peoples to this landscape may hold important implications for the hypothesized 'Paleoindian' migration into the Americas via the West Coast.

## Application of Geoarchaeology

It is for these reasons that a landscape or geoarchaeological approach to the identification process is critical. The approach I propose involves focusing on static landscape attributes with a primary assumption that targeted archaeological discovery is dependent on geologic awareness. Colonizer age archaeology has exceedingly low probability to progress if simple surface archaeological surveys or surveys with insufficient subsurface sampling methods remain the norm. By understanding the chronology and distribution of regional geologic deposits and pedostratigraphic sequences it is possible to develop specific strategies for targeted site identification. With sufficient detail, it is further possible to isolate areas within which sites of specific ages are sought. It is critical to apply subsurface archaeological discovery strategies that fully accommodate archaeological potential, not based in arbitrary sampling methods, rather, founded in precise understanding of the geological parent material underlying the ground surface.

Across the Columbia Plateau there is marked differential visibility of archaeological material from various upper-Pleistocene and earliest Holocene strata. In alluvial settings the surface horizons contain late prehistoric archaeology and Colonizer horizons lie deeply buried. In megaflood settings, depth to upper-Pleistocene flood sediment is often less than one meter. The full range of culture history is compressed to a narrow range and the probability for identification of Colonizer age archaeology is relatively high, although potential for mixing with younger deposits is also high.

A primary assumption related to archaeological visibility is that of patterning of human behavior. Archaeological site locations are recognizable because humans utilize the same resources on the landscape and transportation routes to those resources time and time again. This behavior results in landscape patterns which are discernable to archaeologists. While this principle is true for established archaeological cultures, is it reasonable to expect that colonizers of unknown landscapes left similar archaeological signatures? In other words, are colonizing populations sufficiently familiar with a landscape to return habitually to the same space-time location? I propose that, except for artifact concentrations left along transportation routes (which tend to be concentrated along drainage paths), much of the signature of initial colonizers should essentially be non-patterned. That is not to say that their daily pursuits were random; rather, that until humans understood the regional resource base and incorporated that knowledge into their active resource selection schemes, the likelihood of archaeological identification of resource extraction locales (and other classes of sites) as a result of pattern recognition, is relatively low.

The task of researchers interested in identifying colonizer archaeology is markedly more difficult than identifying clusters of artifacts related to established archaeological entities. Archaeological material left behind by post-colonization cultures includes representative clusters of well-defined technologies deposited by people who utilized similar locations on a regular basis. Colonizer archaeology, therefore, may be as elusive to the researcher as it was to the colonizer, requiring similar modes of inquiry, although with far less direct evidence.

Region-scale geologic processes have led to uneven visibility of colonizer-age archaeological sites. Megafloods in the interior Columbia Plateau affected preservation of colonizer sites in the Columbia and Snake River trenches (most sites deposited on the alluvial floodplain would be scoured, sending artifacts downstream). The same floods crossed the upland areas, differentially scouring and filling the topographic lows. In other areas, glacial advance and retreat would destroy or very deeply bury colonizer sites.

**Study Goals**

An initial goal of this study was to identify characteristics of the Colonizer landscape of the Pacific Northwest region that would lend themselves to the detection of Colonizer period archaeological sites. The following fundamental questions are addressed:

1. To what extent has the landscape changed over the past 15,000 years, and how has that change affected our ability to identify Colonizer period archaeological sites?

2. Are buried soils or other time-stratigraphic markers representing Colonizer-age landscapes preserved in specific environments throughout the region, and if so, where might they occur?

3. What critical variables are required to analyze the process and details of colonization at a regional scale?

4. To reach preliminary conclusions as to those details and processes of colonization – i.e. the adaptive strategies of the Columbia Plateau's first human occupiers.

5. And to lay the basis for future archaeological work by developing a geoarchaeologically-based methodology for identifying and predicting the likely locations of colonizer archaeology in the Columbia Plateau.

In order to address these questions, this dissertation will evaluate the baseline upper Pleistocene conditions—specifically, piece together key details of the upper Pleistocene landscape, in particular, how it differs from that of today and how to recognize it in the geologic record.

**Structure of the Study**

This dissertation is divided into two sections. The first section, chapters 1-3 provide an understanding of what is presently known of early archaeological manifestations in the Columbia Plateau, their landscape setting, defining the study framework and establishing the research problem.

This Chapter provides a broad introduction to the nature of the study and establishes a fundamental framework for presentation of subsequent arguments. Chapter two provides an overview of the state of knowledge regarding early cultural manifestations in the Pacific Northwest with particular focus on the Columbia Plateau. It presents a discussion of the development of regional culture histories concentrating on the handful of known Paleoindian sites. This provides context for a critical analysis of these sites within a geoarchaeological framework in chapter six.

Chapter three establishes the Quaternary geologic foundation of the Columbia Plateau within the context of the overall Pacific Northwest regional geology. It identifies and characterizes specific geologic bodies, their mode and tempo of emplacement and transformation and their archaeological potential. The overall goal is to provide a geoarchaeological overview of the breadth of archaeological landscapes found on the Columbia Plateau and portions of the outlying region.

Part two of the dissertation presents original research that serves to address colonization of the region based on the nature of some baseline resources during the colonizer period. Chapter four builds upon the outline of geoarchaeological environments presented in section one by examining a specific aspect of Columbia Plateau stratigraphy in detail, the presence of buried, time-diagnostic geosols which are found in sedimentary environments across the region both east and west of the Cascade mountain range. These geosols are defined and explored through standardized analytical and reporting methods for soils data. The chapter includes an overview of their discovery, a brief discussion of the role of paleopedology in targeted geoarchaeological research, and pertinent details which establish a regional pedostratigraphic framework, a critical tool in searching for and recognizing Colonizer archaeology.

Chapter five examines the nature of lithic resources in the Pacific Northwest, focusing on baseline lithic resources Colonizers may have discovered and exploited. It discusses specific stone source locations, by stone type. It provides an overview of sourcing data that is known from the literature and introduces significant new data on Paleoindian use of obsidian sources. Most importantly, this chapter describes details of a new source of stone, the Beezley Chalcedonies.

Chapter six presents an analysis of known early Paleoindian sites including sites that are new to the literature that I have located and investigated, within the context of the regional geoarchaeological framework. This chapter focuses, site by site, on common landscape and geomorphic attributes shared by these early sites, focusing on how they differ from later regional archaeological manifestations. The purpose of this chapter is to present a unified analysis of known archaeological landscapes in order to demonstrate the ability to extrapolate this knowledge to other locations with high probability of identifying Colonizer period archaeology.

Chapter seven, the concluding chapter, summarizes the results of the thesis. It presents a closing position on the types of specific environments and stratigraphic features that are likely to contain Colonizer period archaeological sites. Topics for future research that build out from this study are presented.

**Nature of the dissertation data**

In addition to synthesizing the excellent work of decades of regional field researchers, much of the work I present in this dissertation is based on my own original fieldwork and related work. I am a practicing, professional archaeological geologist in mid-career, and a relative late-comer to this graduate work. I have led field research on more than 300 projects, many of which have helped to steer me along a research path. A benefit, however, of taking on a mid-career dissertation research project is the accumulation of data through time. This work is based on two decades of targeted archaeological and geological research in the Pacific Northwest region. The concept, research design and execution of the research included in this dissertation, where it is not presented as part of the regional synthesis, is based on my original research.

**Field and Lab Methodologies**

Field methodology for this dissertation project followed standardized methods used by the author for the past 20 years. Horizontal and vertical control for the recording and collection of stratigraphic profiles and sediment samples was determined as measured from the ground surface to depth. Stratigraphic profiling and sampling followed the excavation of pie-shaped trenches, in order to allow maximum visibility and to provide a rapid mode of egress should the trench fail. Generalized soil and stratigraphic profile descriptions were developed from the profiles and conform to standardized terminology employed by the Department of Agriculture, Natural Resource Conservation Service (Soil Survey Staff).

**Procedures for recording soil characteristics in the field**
Each of the soil profiles presented in this work was recorded in the same manner. This included identifying, measuring and recording the horizons in the stratigraphic profile at each road cut, pit or trench. The physical and chemical properties that characterize each horizon were measured and recorded. The profile was photographed and samples were recovered from each horizon. Methods of each step follow.

*Identifying and Measuring Soil Horizons*

1. Whenever possible the sun shone on the profile.
2. Using a trowel or knife, exposures were "plucked" by removing a few centimeters of soil off of the profile to expose a fresh soil face and to get an understanding of the soil structure and horizonation.
3. The face of the profile was wetted with a sprayer after the initial observations were recorded on a dry face.
4. Beginning at the bottom of the profile, soil characteristics were recorded moving towards to the top of the profile.
5. Working in a straight vertical line, a marker was placed (nail with tape) at the upper and lower horizon contacts to clearly identify them.
6. The top and bottom depths of each horizon were measured beginning at the top of the profile, at the 0 cm mark.
7. The top and bottom depth of each horizon were recorded on the Soil Characterization Data Sheet.

*Measuring Soil Structure*

1. Using a trowel or other digging device a sample of soil from the horizon being studied was removed.
2. Holding the sample gently in hand, the soil was examined to determine its structure.
3. Possible choices of soil structure include:
    - **Granular**: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.
    - **Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.
    - **Prismatic**: Vertical columns of soil up to several cm long.
    - **Columnar**: Vertical columns of soil that have a white, rounded salt "cap" at the top.
    - **Platy**: Thin, flat plates of soil that lie horizontally.
4. Structure was recorded on the Soil Characterization Data Sheet.

*Measuring Soil Consistence*

1. A ped from the soil horizon being studied was removed. If the soil was very dry, the face of the profile was moistened by spraying water on it.
2. Holding the ped between thumb and forefinger, the ped was gently squeezed until it failed.
3. One of the following categories of soil ped consistence was recorded on the Soil Characterization Data Sheet.
    - **Loose**: trouble picking out a single ped and the structure falls apart before you can hold it.
    - **Friable**: The ped breaks with a small amount of pressure.

- **Firm**: The ped breaks when you apply a good amount of pressure and the ped dents your fingers before it breaks.
- **Extremely Firm**: The ped can't be crushed with fingers

*Measuring Soil Texture*

Soil texture was determined in both the field and the lab following the procedure outlined in table 1.1.

*Photographing the Soil Profile*

1. A metric tape was laid across the profile face with the 0cm mark at the surface.
2. Profiles were photographed so that the horizons and depths can be seen clearly.

**Table 1.1 Field Method for Identification of Soil Texture**

| Soil Texture | Visual Detection of Particle Size and General Appearance of the Soil | Squeezed in hand and pressure released | | Soil ribboned between thumb and finger when moist |
|---|---|---|---|---|
| | | When air dry | When Moist | |
| Sand | Soil has a granular appearance in which the individual grain sizes can be detected. It is free-flowing when in a dry condition. | Will not form a cast and will fall apart when pressure is released. | Forms a cast which will crumble when lightly touched. | Cannot form ribbon. |
| Sandy Loam | Essentially a granular soil with sufficient silt and clay to make it somewhat coherent. Sand characteristics predominate. | Forms a cast which readily falls apart when lightly touched. | Forms a cast which will bear careful handling without breaking. | Cannot form ribbon. |
| Loam | A uniform mixture of sand, silt and clay. Grading of sand fraction quite uniform from coarse to fine. It is mellow, has somewhat gritty feel, yet is fairly smooth and slightly plastic. | Forms a cast which will bear careful handling without breaking. | Forms a cast which can be handled freely without breaking. | Cannot form ribbon. |
| Silt Loam | Contains a moderate amount of the finer grades of sand and only a small amount of clay. Over half of the particles are silt. When dry it may appear quite cloddy which readily can be broken and pulverized to a powder. | Forms a cast which can be freely handled. Pulverized it has a soft flourlike feel. | Forms a cast which can be freely handled. When wet, soil runs together and puddles. | It will not ribbon but it has a broken appearance, feels smooth and may be slightly plastic. |
| Silt | Contains over 80% of silt particles with very little fine sand and clay. When dry, it may be cloddy, readily pulverizes to powder with a soft flourlike feel. | Forms a cast which can be handled without breaking. | Forms a cast which can freely be handled. When wet, it readily puddles. | It has a tendency to ribbon with a broken appearance, feels smooth. |
| Clay Loam | Fine textured soil breaks into very hard lumps when dry. Contains more clay than silt loam. Resembles clay in a dry condition; identification is made on physical behavior of moist soil. | Forms a cast which can be freely handled without breaking. | Forms a cast which can be handled freely without breaking. It can be worked into a dense mass. | Forms a thin ribbon which readily breaks, barely sustaining its own weight. |
| Clay | Fine textured soil breaks into very hard lumps when dry. Difficult to pulverize into a soft flourlike powder when dry. Identification based on cohesive properties of the moist soil. | Forms a cast which can be freely handled without breaking. | Forms a cast which can be handled freely without breaking. | Forms long, thin flexible ribbons. Can be worked into a dense, compact mass. Considerable plasticity. |

*Archiving the Sediment Samples*

In order to create a permanent record of the soil profile, each soil horizon was sampled, with peds intact, into a custom-designed soil box. Each soil box contains eight separate compartments that will allow the soil profile to be viewed in proper stratigraphic order.

Soil horizon depths corresponding to each sample were recorded on each compartment. The soil boxes are archived in the Wanapum Heritage Center repository and are available for examination by bona fide researchers.

**Radiocarbon Dates**

Interpretations of the sediment sequences presented in this dissertation were enhanced by the application of radiocarbon dating. Samples were submitted to Beta Analytic, Inc. and Stafford Research Labs. Except where noted otherwise, all radiocarbon data is presented in radiocarbon, not calendric years; calendric corrections for all dates are presented in the cross-referenced radiocarbon tables throughout the text, and were calculated using Calib 6.0 (Reimer et al. 2009). Three material types were targeted for radiocarbon analysis, including bone (all collagen dates), charcoal and total humates (from bulk soil samples). Unless otherwise noted, all dates were determined by standard radiocarbon dating methods; accelerator mass spectrometry (AMS) dates are indicated by the Stafford labs label prefix “CAMS”, or simply by AMS next to the sample number.

# CHAPTER 2
# COLONIZER PERIOD ARCHAEOLOGY

## Introduction

Chapter 1 identified parameters that I believe to be useful for analyzing colonizer archaeology. These included general concepts of a hypothetical colonizer tool kit that is based (at least in part) on blade production, broad ideas of where to look for colonizer site locations and a relevant temporal framework. This chapter establishes what is known of the early cultural manifestations in the Pacific Northwest region. The goal is to provide an overview of the published archaeology and to introduce new colonizer period archaeological sites as context for subsequent chapters.

Initial colonization of the North and South American continents occurred at the close of the Pleistocene period. Although consensus agreement by Upper Pleistocene researchers is not yet achieved, the most parsimonious hypothesis at the moment is that humans entered the continent with the aid of watercraft via the Pacific coastline of western North America (Dixon 1999; Steele and Rockman 2003). These colonizers and their offspring left hallmark tools in the form of stemmed and lanceolate projectile points—and, sparsely distributed across the region, fluted points (Avey, 1991; Willig 1989). In addition to professionally recorded archaeological sites, private artifact collections across the region contain a wide variety of these early projectile types which likely reflect both the initial colonization of the area, and a several thousand-year period which followed, as populations grew and mobility patterns increasingly moved towards middle Holocene archaic adaptations (characterized by the Old Cordilleran culture of B. Robert Butler, 1961). Colonizing populations are distinguished from their cultural successors by their broad foraging range, distinct patterns of land use and exploitation of toolstone resources (Chapter 5 below).

Archaeology in the Pacific Northwest region includes Clovis and other fluted point sites and a small handful of sites where people made large stemmed points within what is known as the Western Stemmed tradition, including Lind Coulee, Windust and Haskett types. These finds are often associated with small assemblages of generalized Paleolithic tool types, including blades, graving tools, burins and scraping tools made on large flakes. Although numeric dates at stemmed point sites are in most cases later than Clovis by approximately 1000 years, radiocarbon dating is inconsistent and poor at most sites; several recently discovered stemmed point sites present stratigraphic associations which may suggest contemporaneous, if not earlier occupation than the narrow Clovis time span offers (Beck & Jones, 1997; Bryan & Tuohy, 1999; Waters and Stafford 2007). The focus of this dissertation is related to the discovery of such sites. And although one of the goals of this work is to depart from the largely culture-history based approach that has dominated Paleoindian studies for a half century to focus on regional issues of site discovery, it is impossible to ignore the sequence of cultural adaptations and the significance of what appear to be "pre-Clovis" sites.

## Previous Work

Several useful overviews of the scant Pacific Northwest upper Pleistocene archaeology exist. David Rice (1985) authored a Resource Protection Planning document for the State of Washington to establish priorities for survey and investigation of Washington state Paleoindian archaeological resources. Rice identified 14 site locations with archaeological manifestations with upper Pleistocene to early Holocene components. Academic treatment of early archaeological sites are presented by Ames (1989) who considers 13 early archaeological sites from which he developed a model of forager mobility strategies, Chatters and Pokotylo (1998) who provide a short summary of the period across all portions of the Plateau, Ames et al. (1998) who focus a broad overview of the southern Columbia Plateau, and Carlson (1996) who provides an overview of early archaeological sites in the Canadian portion of the Pacific Northwest region.

**Overview of Pacific Northwest Paleoindian studies**

The archaeological record of the Northwest begins as early as 14 KBP, if the speared mastodon found at Manis in northwest Washington (Gustafson et al. 1979) and human coprolites from Paisley Caves in south-central Oregon (Gilbert et al. 2008) are taken at face value. Clovis and other fluted projectile points are present in artifact collections, but the Richey-Roberts Cache in central Washington (Gramly 1992) and the Dietz Site in Oregon (Fagan 1988) are the only reported discrete assemblages of this early material. The discovery of the Richey-Roberts cache in East Wenatchee, Washington (Mehringer 1989) marked a turning point in our understanding of cultural historic relationships by expanding the perspective and reorganizing the context of archaeological manifestations of colonizer period occupations across the Pacific Northwest region. But while Clovis has been well-dated to between 10.9-11.2 KBP in other parts of the country (Waters and Stafford 2008) bone collagen in artifacts at the Richey Clovis site appear to be contaminated with recent carbon and have only produced unreliable middle Holocene dates (Gramly 1991). Even so, the site assemblage is associated with tephra from Glacier Peak dating to roughly 11.6 KBP. (Mehringer and Foit 1990). In addition to “dropping the bottom” out of the time-scale of the regional culture history, the discovery of the Richey site also forces an overall evaluation of the role fluted point makers played in regional cultural developments as well as in the overall scheme of North American colonization.

Settlement pattern and economic models for the people who colonized the Pacific Northwest are based largely on evidence from outside the region. In the classic Paleoindian model developed in the American southwest and on the Great Plains, early Paleoindians are considered to have organized into small, highly mobile bands of hunter-gatherers who were dominantly focused on hunting of now-extinct megafauna and foraging for seasonally available plants (Haynes 1991). But in reality, only a handful of sites are interpreted as supporting an economic adaptation that is focused on megafauna. The vast majority of Paleoindian sites are found in a broad variety of environments, in the near absence of megafauna. A parsimonious explanation would suggest that North American Paleoindians practiced a more generalized subsistence pattern that was based on a diverse variety of resources (Grayson and Meltzer 2002) and at least some colonizers of the Pacific Northwest region appear to have practiced similar economic pursuits (Ames et al. 1998; although Ames uses the term “Pioneer” rather than “Paleoindian” when discussing early peoples). Similarly, while the roots of the model reach back decades, mounting additional evidence supports the hypothesis in the Pacific Northwestern region, that colonizers practiced a littoral adaptation (Bedwell 1973, Graff and Schmitt 2007; Chapter 7, this work). Ames (1989) and Chatters and Pokytylo (1998) have referred to colonizer groups as collector-like foragers (see discussion below).

Sites associated with colonizer occupations are relatively unknown in upland settings (but see new sites and isolated artifacts presented in this chapter and Chapter 6). The colonizer period sites that are known from the river corridors tend to be relatively late (in the 9-10 KBP range), and many are inundated or otherwise unavailable for new field research. The few archaeological sites associated with the colonizer period often contain volcanic tephras associated with Mt St. Helens and Glacier Peak eruptions dating about 11.6 KBP (Chapter 6)

The upper Pleistocene and early Holocene period in the project area is represented by multiple archaeological cultures which produced a relatively limited range of tool types. While the initial colonizers of this period are unknown, it is clear that people of the fluted point tradition had an ephemeral presence, but the relationship of the fluted point tradition to the stemmed point tradition is still unclear. Initial colonizers entered the region at least by 14,000 years ago, and ties to their lifeways lasted until at least 9000 years ago.

While colonizer dwellings of the first peoples of the region are not known, it is reasonable to expect that the immediate cool and wet post-glacial temperatures would have necessitated shelter of some form. Rockshelters and caves abound along the Columbia and Snake River valleys and rare cave localities in the uplands also exist. Cave and shelter occupations are clearly part of the colonizer period in the Northern Great Basin where colonizers may have moved from the Columbia Plateau. The presence of a cache at the East Wenatchee Clovis site, suggests that storage technologies other than those found in caves or rockshelters may have been available and used by the earliest people in the Columbia Basin. Dwellings most likely included both summer and winter structures, but it has been assumed that these structures would have been temporary forms that correlated with a highly mobile, foraging subsistence lifestyle. Evidence for potential structures exist at Sentinel Gap and Kettle Falls (see below). As a note of caution here, recently (August 2010) a Mesolithic house at Star Carr, northern England, dated to 10.5 KBP was identified. Only scant information is available as of this writing (BBC news 2010). The house was round, reported to be a smaller version of iron age round houses, with a circle of timber posts around a sunken, circular floor area. The house appeared to have been rebuilt over time--suggesting at least a semi-permanent presence of occupants--within an archaeological scheme that has long been considered highly mobile, like the early American colonizers. Similar issues of semi-permanence among otherwise broad-ranging foragers have been considered from apparent Upper Paleolithic residential base camps of the central Russian plain (Soffer et al. 1997).

The sediment load still carried by the Columbia and Snake Rivers throughout the majority of the colonizer period is not thought to be conducive to salmon spawning (Schalk 1986; cf. Butler and O'Conner 2004 and Reid et al. 2008). The lack of salmon remains in archaeological sites however, cannot be taken as primary evidence that salmonids were not harvested, processed, and consumed by site occupants (Stevens and Galm 1991), it may simply reflect the relative difficulty which anadromous fish species had as they re-established their populations following centuries of catastrophic flooding along the Snake and Columbia rivers, or (more practically), it may simply reflect the common archaeological practice of screening recovered archaeological sediments through ¼ inch mesh, allowing most fish bones to pass through (Bretz 1969; Jarrett and Malde 1987).

While there is little documentation on the presence of native fish in sediment rich streams during this time period it is impossible to overlook the direct evidence that is offered by the Buhl and Gore Creek skeletons and by the “Stick Man” cranium. The Buhl site is a human burial located near the town of Buhl, Idaho, which dates to 10,675±95. The burial is a Paleoindian woman with grave offerings including an unutilized stemmed Windust projectile projectile point, an eyed bone needle, two bone fragments that are likely from a bone artifact, and a badger baculum (penis) bone. Gore Creek is a skeleton found in British Columbia in 1975 (Cybulski et al. 1983). It dates to 8,250 ±115 and was found in the Badger Mountain Geosol underlying tephra from Mt. Mazama. The skeleton is nearly complete, minus the skull, and is considered to have been killed and buried by a mudflow. Stick Man is a cranium of indeterminate origin that has been held at the Central Washington University curation facility for several decades (Chatters et al. 2000). Measurements of stable carbon isotopes from all three sets of remains indicate reliance on both terrestrial and aquatic resources with some contribution by marine fish (Green et al. 1998; Chisholm and Nelson 1983). This indicates that marine resources made up at least a partial contribution to the diet of the colonizer period. Given the abundant lakes throughout the region at the close of the Pleistocene, the extraction of non-anadromous fish should also be considered as part of the probable resources available to initial colonizers of the Pacific Northwest—details of the overall contribution of anadromous fish to early people will require substantial further research either as new sites with preserved fish remains are identified, or as more early human skeletons are inevitably discovered and made available for research.

## Cultural Traditions and Chronology

The US Army Corps of Engineers have recently completed work on a regional archaeological overview focusing on the southern Columbia Plateau (USACOE in prep.). Two sub-periods which were not parsed out by other authors are presented in the synthesis: Early Sub-period A, 13.4 to 9 KBP, and Early Sub-period B 9 to 7.5 KBP. These divisions, not coincidentally, correspond to key periods of pedogenesis represented by the Bishop and Badger Mountain Geosols (see Chapter 4). Sub-period B therefore only represents a lower limiting boundary age—the actual age of archaeology that was deposited on the stable surface which was buried by Mazama tephra (a volcanic marker horizon described in Chapter 3) is likely older than 7.5 cal KBP, likewise with the earlier surface, although local landscape transformations may have obscured, or in some cases obliterated archaeological evidence.

Numerous authors have long presented evidence for potential overlap in time between Fluted and Western Stemmed traditions (numerous chapters in Willig et al. 1988; Davis 1998). Despite a lack of clear dates for Clovis and fluted point makers in the Pacific Northwest, Alan Bryan and Ruth Gruhn have long presented their cases for a pre-fluted point occupation of the entire western Cordilleran. Recently, Davis (2003) and Gilbert et al. (2008) have presented new data that may help to establish exactly that. The Corps’ Early Sub-period A begins by explicitly presenting such a relationship; the Southern Plateau is characterized as being occupied by contemporaneous archaeological traditions: Fluted Point and Western Stemmed peoples, both of whom are detailed below. The following discussion is based in part on work that was carried out by the author, together with James Chatters and Steve Hackenberger over the past decade (Lenz et al. 2003, 2004; Chatters et al. 2007, 2010).

## Western Stemmed Tradition (11.37 to 8.41 KBP)

The Western Stemmed Tradition is known by a variety of culture-historic terms across the region, including the Youngs River Complex and Philipi phase on the Columbia River (Dumond and Minor 1983 Minor 1984), the Goatfels Complex on the Kootenai (Choquette 1996), Haskett in southern Idaho (Butler 1965), and the broadest application, the Windust Phase across the Columbia Plateau (Leonhardy and Rice 1970). The Windust phase, with a proposed age range of 11 – 8.2 KBP, is extrapolated from the Snake River sequence of the same name (Table 2.1; Leonhardy and Rice 1970, H.S. Rice 1965). The term is used colloquially across a broad range because projectile points diagnostic of this phase have been observed as surface manifestations across the region. Rice (1972) defined the Windust Phase based on data from 1328 artifacts at 3 archaeological sites; the Windust Caves (480 artifacts), Marmes Rockshelter (440 artifacts) and Granite Point (408 artifacts). Based on data presented above for the colonizer sequence, significant overlap in the early portion of the time sequence for the Fluted and Windust traditions is clear.

As it is presently defined, the Windust phase includes a formalized chipped-stone technology including straight or contracting stemmed points and uniface and biface lanceolate points, edge-ground cobbles, a well-developed bone tool technology, a variety of other scrapers, bone atlatl spurs, and *Olivella* beads. The presence of marine shell beads in assemblages dating to this time period indicates the presence of extra-area trade networks—likely a byproduct of initial colonization from the Pacific Coast, up the Columbia River Valley. *Olivella* and *Dentalium* shells are found in coastal Washington and on beaches in southern California (Galm 1994). Perishables and wood technologies have yet to be identified with Windust artifact assemblages.

Subsistence strategies during the Windust phase include a broad-based foraging adaptation focused on littoral environments, the taking of large mammals, such as bison, elk, and deer and the gathering of plant and aquatic foods. Salmon remains are identified from Windust Phase sites (Cressman 1960; Chatters 1986); however, little direct evidence for fishing exists, a fact that may be due to significant sampling error. Upland environments were heavily relied upon with a secondary focus on riverine habitats, exploiting seasonally available resources—a defining point of the adaptive strategy that is also a focus of this research. Large mammal hunting supplemented by a small game, fish, river mussels, and gathering adaptation are recognized as economic pursuits associated with the Windust phase. Caves, rockshelters, and open sites were utilized and possible evidence for a house floor in the Kettle Falls region is reported in the Windust Phase (Chance and Chance 1985).

The Western Stemmed Tradition (WST) is associated with a complex toolkit composed of lithic, bone and organic technologies. Lithic tools include stemmed and lanceolate projectile points, bifacial cores that ultimately became projectiles or knives, large bifacial reduction flakes fashioned into end and side scrapers, burins, gravers and drills. Individual flakes driven from bifacial cores were utilized as tools and retouched into working tools.

Stemmed points were manufactured via bifacial percussion and finished by taking broad, collateral flakes off of the dorsal surface of a formed blank or biface core. Bifacial points were heavily retouched, so that with use through time, they ended up as exhausted, stemmed remnants. (e.g. Butler 1965; Rice 1972). It is possible that WST bifaces were heavily used as knives as the incidence of bending fractures and intensity of reworking suggest (e.g. Ahler 1971). Expedient cobble tools, milling stones and manos have been recovered in association in Western Stemmed assemblages, but the frequency of grinding tools is markedly less than that observed for the flaked tools. Aside from the relatively ubiquitous lithic assemblage associated with the culture group, two unique tool types are observed in WST toolkits; flaked crescents and bola stones, finely-crafted, longitudinally-grooved ground stone tools have been recovered or observed at Western Stemmed sites.

Rarely, under optimal conditions of preservation, a complex array of bone and composite artifacts occur in WST assemblages. Single piece and composite shafts, unilaterally barbed harpoon points, atlatl spurs, awls, needles, wedges, and other modified bone implements have been observed at several WST sites (Figure 2.5; Galm and Gough 2000; Irwin and Moody 1978; Leonhardy 1970; Rice 1972). Awls and fine bone needles are present. Together, diversity in the WST toolkit represents a complex technology with a high degree of planning depth (Torrence 1983).

On a regional scale, individual WST artifact types display a high degree of patterning indicative of systematic and specific use of habitat and support the ‘seasonal round’ model of site occupation. Observing the presence/absence of the two specialized lithic tools found in association with WST sites, crescents and bolas, an interesting trend arises. Crescents, for example, have only been found in upland settings, near wetland areas. Although the only in-context specimens come from Lind Coulee (Daugherty 1956), collectors have also found them at Willow Lake and at upland spring sites (this dissertation). Bolas, conversely, have been found almost exclusively in lowland settings—along rivers and their nearby terraces. Numerous examples have been found at the mouth of Pend Oreille Lake (Weisz, personal communication 2006), Rock Island Rapids (Valley 1975), Five-Mile Rapids (Cressman et al. 1960) and as isolates on the terraces of the Portland Basin (Pettigrew 1981). At the Pilcher Creek site in the Blue Mountains of northeast Oregon bola stones appear in the lithic assemblage (Brauner 1985). The distribution of two unique lithic artifacts further illustrate the complexity

Table 2. 1 Western Stemmed Tradition site chronology in the Pacific Northwest (After Chatters et al. 2010).

| Site | 14C Age Range | Calibrated Age cal | Reference |
|---|---|---|---|
| Granite Point | 14,100±1,160 | N/A | Leonhardy 1970 |
| Lind Coulee | 12,830±1,050 (WSU-1707) | N/A | Irwin and Moody 1978 |
| | >11,600 | N/A | This study |
| Cooper's Ferry | 11,410±130 TO-7349 11,370±70 Beta-114949 8,410±70 | 13,900-13,050 13,300-13,179 9518-9321 | Davis and Sisson 1998 |
| Hatwai I | 10,820±140 (TX–3159) 8,830±310 | 12,926-12,570 10,249-9528 | Ames et al. 1981 |
| Marmes Rock Shelter | 10,810±300 (WSU-363) | 13,094-12,386 | Sheppard et al. 1987 |
| | 10,750±100 (WSU-211) | 13,094-12,386 | Fryxell et al. 1968 |
| Buhl | 10,675±95 (Beta-43055) | 12,830-12,641 | Green et al. 1998, |
| Wildcat Canyon | 10,600±200 (GAK- 1322) | 12,832-12,240 | Cole 1965 |
| Marmes Rock Shelter | 10,475±270 (WSU-366) | | Fryxell et al. 1968 |
| Wewukiyepuh | 10,270±50 (Beta-124446) | 12,134-11,840 | Sappington and Schuknecht 2001 |
| Lind Coulee | 10,250±40 (CAMS94857) 9810±40 (CAMS95524) | 12,083-11,837 11,241-11,204 | Craven 2003 |
| Banff: Vermillion | 10,200 (GSC-3065) 9,600 | 12,028-11,820 11,102- 10,790 | Fedje 1995 |
| Ft Rock Cave | 10,200±230 (GAK 2147) 8,550±150 (GAK 2146) | 12,346-11,231 9743-9318 | Bedwell 1973 |
| Sentinel Gap | 10,180±60 Beta 125771/ AMS | 11,999-11,758 | Galm and Gough 2000 |
| Marmes Floodplain | 10,130±300 W-2218 9,710±40 (W-2209) AMS | 12,341-11,249 11,203-11,126 | Sheppard et al. 1987 Hicks et al. 2004 |
| Redfish Overhang | 10,100±30 (W-2218) | 12,337-11,230 | Sargeant 1973 |
| Paulina Lake | 9,970±40 AMS | 12,347-10,785 | Connolly and Jenkins 1999 |

Table 2.2 (Cont.) Western Stemmed Tradition site chronology in the Pacific Northwest (After Chatters et al. 2010)

| | | | |
|---|---|---|---|
| Hetrick | 9,850±110 | 11,599-11,163 | Rudolph 1995 |
| Connely Cave #5B | 9,540±260 (Gak-1744) | 11,204-10,514 | Bedwell 1973 |
| 35LK1881 | 8,940±60 (BETA85687) AMS | 10,196-9932 | Oetting 1994 |
| 35LK2076 | 8,810±100 (BETA101739) AMS | 10,133-9688 | Oetting 1994 |
| Cougar Mt. Cave | 8,510±250 (UCLA-112) | 9887-9136 | Radiocarbon 1962 |

that WST peoples exhibit. Their complex toolkits are well adapted to the environment the culture group is exploiting.

Milling stones suggest that seed use was common among Western Stemmed people, but only the faunal portion of the Western Stemmed diet is well understood. Faunal assemblages are variable and focused on a particular resource; in the south, rabbits and birds dominate the faunal assemblages (e.g. Oetting 1994; Pinson 2004), where in the north, larger game are prevalent, with some smaller prey (Wilson 2008). While not unknown in the Western Stemmed diet, fish do not make up a substantial part. It is entirely possible this is due to sampling error, as archaeological recovery methods vary through time.

Western Stemmed Tradition people left few traces of permanent dwellings (but see Connolly 1999). Social groups were likely small and very mobile. On the few occasions where single event camps are found or can be discerned such as at Lind

Coulee (Irwin and Moody 1978) and Sentinel Gap (Galm and Gough 2000), camps cover at most a few hundred square meters. Feature and artifact patterning is discrete and discontinuous, indicative of short-term occupancy and, therefore, high residential mobility. Chatters et al. 2010 compared Western Stemmed and Old Cordilleran assemblages from Granite Point and Beech Creek, the two sites that allow clear separation of assemblages from the two traditions. In both cases, the Western Stemmed Tradition assemblages were much more expedient, indicating a lower level of mobility (Hayden et al. 1996). Although I do not intend to include the Old Cordilleran tradition in the overall discussion of colonizer archaeology (due to its archaic (late) time frame) the implication of Chatters' study, particularly the notion of lower mobility than an archaic people group, is important.

Initial work related to WST settlement patterns assumed that village sites occurred exclusively along the river corridors (Ames 1988, Ames et al. 1998). Recent work has challenged this assumption as it is clear the culture group made much more extensive use of their landscape. Sites like Rock Island Overlook (Valley 1975), Marmes Rock Shelter (Rice 1969) and Five-Mile Rapids (Cressman et al.1960) are in fact located on regional trunk streams, but sites also occur in upland areas at Sentinel Gap and the Portland Basin (Galm and Gough 2008) and in wetland areas of the intermountain plateaus evidenced at Lind Coulee (Daugherty 1956), Willow Lake, and Bishop Springs sites (Huckleberry et al 2003; this Dissertation). Cascade and Rocky Mountain sites include the Judd Peak Rock Shelter (Daugherty et al. 1987a), Vine (Lewarch and Benson 1989), and Pilcher Creek (Brauner 1985). Western stemmed isolates and sites are recognized at Pend Orielle (Miss and Huson 1987), Palmer (Salo 1987), and Goose lakes. Inland wetlands and lakes seem to have been particularly favored. WST settlements in southeastern Oregon are commonly observed near Upper Pleistocene to earliest Holocene lakes and as such, led to their inclusion in Bedwell's (1973) Western Pluvial Lakes Tradition culture group (Connolly and Jenkins 1999).

WST people appear to have practiced a seasonal round, based on their known site distributions. The larger sites indicate repeated use through time. Lind Coulee is interpreted as a hunting camp, although a broad variety of activities appear to have taken place there (Irwin and Moody 1978; Wilson 2008). The Goldendale Site was a seed gathering camp (Warren et al. 1963) and Marmes Rock Shelter is interpreted as a winter encampment (Hicks et al. 2004). Rock Island, Kettle Falls and Five Mile rapids are located at prime fisheries. The breadth and volume of artifacts at these sites suggest they are foraging base camps. Ames (1988) divided WST sites into large sites, those with many tool types and small camps, those with relatively few tools.

Relatively few sets of human remains have been observed in association with WST assemblages all with little to no discernable patterning in depositional context. At this point only four sets of human remains are known from WST contexts. These include Marmes Rock Shelter (Krantz 1972), Buhl (Green et al. 1998), Kennewick (Chatters 2000), and Stick Man (Chatters et al. 2000). Buhl was buried alone and appears to have been abandoned or secondarily deposited. Kennewick Man, whether interred (Huckleberry and Stein 1999) or abandoned (Chatters 2000), was also apparently alone. Stick Man was an interment, but it is not possible to know if he was interred with a group.

In the eastern portion of the study area, a concentration of western stemmed points known as Haskett have particularly high incidence. Haskett points occur across the

Pacific Northwest region, but the highest concentrations are found in Idaho; they represent a shared Great Basin/Columbia Plateau Western Stemmed tool type. The earliest dates from buried contexts are known from the Sentinel Gap site in the central Columbia Plateau, where two dates of 10,300 were taken on charcoal from a living surface (Galm and Gough 2000). B. Robert Butler originally identified the Haskett Type projectile point while excavating the Lake Channel type-site near the American Falls Reservoir in Eastern Idaho (Butler 1965). Butler defined two primary Haskett projectile point types within the Haskett Tradition, type I and type II. Haskett Type 1 points are defined by the broadest and thickest point on the blade existing near the distal end of the biface. They have an edge-ground base that tapers into a rounded stem, comprising on average, 60 percent of the biface length (Butler 1965). Haskett Type II points are much longer, they display thicker cross-sections, and unlike Type I, the blade to base ratio is roughly 1:1. Like many Great Basin and Western Stemmed points, they often display broad, shallow collateral flaking that feathers out, often imperceptibly, near the mid-line on both faces, creating a lenticular cross-section.

Marler (2004) presents details of a high concentration of isolated Haskett points and sites containing Haskett points at the Idaho National Laboratory on the eastern-most margin of the Columbia Plateau in central Idaho. Marler found that nearly half of all projectile points identified there and slightly less than half of the recorded archaeological sites include Haskett points. Similar concentrations are known from the Saylor Creek range in south western Idaho. At this location, colonizer period sites cluster within a very small geographic area and display highly patterned landscape use along shallow drainages that are tributary to the Snake River. Colonizer period foragers utilized the upland zones away from Snake River to hunt and possibly to collect seeds. They followed topographic lows created by drainages, using the alluvial bottoms to stalk and kill game which grazed on the higher terraces. Continued work at these locales will contribute significant information regarding details of Haskett site distribution, landscape use and possibly details of timing and relationship to the broader Western Stemmed tradition that are at present, immature.

In brief summation, Western Stemmed people were mobile foragers who practiced a broad subsistence round utilizing a highly diverse toolkit modified by environmental variables. Ames (1988) and Chatters (1985) have referred to people of the Western Stemmed tradition as “collector-like foragers” due to their apparently extended-residence time in base and field camps.

**Fluted Tradition (11.2 to 10.3 KBP)**

The present understanding of the Fluted Tradition is primarily based on data from outside the Pacific Northwest region. While Fluted points are well dated at a handful of Clovis sites in other parts of the country (Waters and Stafford 2008) the three significant sites within the Pacific Northwest region, the Simon Site in southern Idaho (Butler 1965), the Richey site in central Washington (Meheringer 1988) and the Dietz Site in Oregon (Fagan 1988) do not have more than broadly associated limiting ages. The Richey-Roberts site in East Wenatchee post-dates the eruption of Glacier Peak (11.6 KBP) as Glacier Peak tephra is found adhering to the underside of some of the artifacts. Attempts at radiocarbon dating archaeological bone at the site have failed, leaving its actual age unknown (however see Chapter 6 for a detailed relative chronology). In the extreme eastern portion of the southern Columbia Plateau, the Simon Clovis Cache is undated, and the same is true of Dietz to the south.

Lithic and bone technologies of the Fluted tradition are characterized by a finite range of artifacts. Callahan (1979) described finished fluted points as being characterized by regular, straight edges, a symetrical blade, a regular, biconvex cross-section, flutes on both sides, a blade characterized by relatively small biface thinning flakes that usually extend only past the medial ridge of the blade, and a regular pattern of small retouch flakes along most of the blade margin. The retouch flakes and biface thinning flakes are a byproduct of thinning the blade, straightening the edge, and fluting.

One reduction strategy that characterizes the Fluted Tradition is the systematic thinning of biface cores and blanks by "overshot" flaking techniques, where the knapper attempts to drive the flake across the face of the biface core, sometimes removing the opposite blade margin. The broader Fluted Tradition toolkit includes bone foreshafts, beveled-base bone points, scrapers, blades, blade cores, spokeshaves, hammer stones, and a variety of scrapers and retouched flakes (Frison 1990; Ames et al. 1998). Formed bone objects, large bifacial cores and bifacial blades, fluted points, unifacial implements and debitage were recovered at the Richey-Roberts East Wenatchee Clovis site (Ames et al. 1998:103). Fluted points and associated tools are generally manufactured from extremely high-quality crypto-crystalline silicates or obsidian (Amick, 1995; Beck and Jones, 1990; Chapter 5, this work).

In other regions where Clovis sites are present in higher densities, interpretations of Clovis subsistence are based on the presence of kill sites (Meltzer 1993). Although it has become common to consider Clovis subsistence as generalized (Cannon and Meltzer 2004; Grayson and Meltzer 2002, 2003), rather than specialized, in environments that are conducive to bone preservation, megafauna remains exist (Haynes 2002; Waguespack and Surovell 2003). Animals with the highest correlation to Clovis, include Mammoth and the extinct form of Bison. Rare sites include a broad variety of other animal classes, including reptiles, fish, birds and small mammals (Dent 1985; Ferring 2001; Lundelius 1972). Regional Clovis finds have not been found in association with faunal or floral materials or features; too few have been found over all for a pattern to emerge, so little is known about the human behavior they represent in the Pacific Northwest.

No undisputable Fluted Tradition human remains are known from any context in the Pacific Northwest or elsewhere. The fragmentary human remains of two sub-adults were found with the Anzick Clovis cache in Montana, but radiocarbon dating ultimately demonstrated a significantly younger age for the human remains (Lahren and Bonnichsen 1974). The dates are 10.5 KBP, 8.9 KBP and 8.6 KBP, and while they may simply reflect problems that are common to dating old, weathered bone, (similar to the anomalously young Richey dates) they may in fact be good dates on human remains that were not originally associated with the Anzick cache.

**The Archaeological Study Sample**

To provide the context of known colonizer archaeology, I will present relevant details of sites that are known from the literature as well as isolated, time-diagnostic finds from the region (Figure 2.1; Table 2.2 and Table 2.3 and Table 2.). Data from published archaeological sites will be presented as an overview, and I'll augment some sites with new analyses of artifacts or stratigraphic data that is original to this dissertation. I will also present new data from sites and isolates that are not known in the present literature.

Although private collections are known to hold fluted points, aside from the Richey-Roberts cache, only one fluted point site is known from the interior Columbia Plateau. This site, the Winchester Wasteway, is located along an upper Pleistocene drainage (Irwin and Moody 1976; this work). A fluted point was recovered from back dirt at the Moses Coulee cave near Palisades, Washington (45DO331), but due to its secondary context, it is unknown whether the cave was host to Clovis people or if the point was brought there later in time.

Along the margins of the Plateau, nine locales that are fluted point sites are known from areas along or adjacent to the Snake River Plain. These recorded locations include Alkali Springs (Huntley 1985), Big Springs Creek (Plew and Scott 2003), Blue Lake (Yohe and Woods 2002), Crystal Springs (Titmus 1988), Coyote Wells (Yohe 1993), Lake Cascade (Peterson 1987) Owl Cave (Butler 1978; Miller 1982) the Simon Site (Butler 1963; Butler and Fitzwater 1965; Titmus and Woods 1991) and West Clover (Titmus and Woods 1990).

Among all of these sites, only three are known to come from sites with buried stratigraphic context (Winchester Wasteway, Richey-Roberts and Owl Cave). Owl Cave fluted points are dated at c. 13-11 KBP. (Miller and Dort 1978; Miller 1982), and associated obsidian hydration dates average c.11 KBP. As such, the majority of regional fluted point finds consist of surface discoveries without stratigraphic or depositional context.

The relative few known fluted point locations in the Columbia Plateau are well above the river valleys. Along the Puget Sound, fluted point sites are known from environments that are at present, far from their original setting, largely as a result of the combined effects of isostasy and sea-level rise. In the neighboring Great Basin and in the central portion of the Southern Columbia Plateau in central Oregon, the occurrence

Table 2. 2. Significant Colonizer Sites in the Pacific Northwest

| Site Name | Date(BP) | Location | Discoveries |
|---|---|---|---|
| Wilson Butte Cave | >10,000-6,000 | Jerome, Idaho | • bone and charcoal fragments<br>• stone tools, knives, projectile points<br>• evidence of hearths, and a mano fragment |
| Haskett Site | 10,000-9,000 | Idaho | • Lanceolate points<br>• Flake knives<br>• Haskett Points (similar to Lake Mojave points) |
| Sentinel Gap Site | 10,100 | Mattawa, Washington | • Entire Haskett reduction sequence present |
| Buhl Burial Site | 10,600 | Twin Falls County, Idaho | • One of best preserved and most complete paleoindian skeletons in the Americas<br>• Obsidian stemmed biface<br>• Fine bone needle<br>• Incised bone artifact<br>• Badger bone (baculum used as funerary object) |
| Hatwai Site | 10,800 | Nez Perce County, Idaho | • Windust stemmed and lanceolate points |
| Wasden Site (Owl Cave) | 10,900-8,000 | Bonneville County | • Three fluted Folsom points<br>• Mammoth, bison, camel, dire wolf<br>• Mammoth long bones used to produce bone tools |
| West Bar Cache | ~11,000 | Trinidad, Washington state | • Rare cache of Clovis tools made on single source of lithic raw material |
| Simon Clovis Cache | ~11,000 | Idaho | • Largest and best example of Clovis technology in Idaho<br>• Five complete Clovis points<br>• Clovis preforms<br>• Quartz crystal bifaces |
| Five Mile Rapids | >11,000 | Dalles, Oregon | • Abundance of salmon, suggesting colonizer age fishing<br>• Early evidence for exploitation of avifauna |
| Cooper's Ferry | 11,410-11,370 | Idaho | • Equipment cache with stemmed points<br>• Long record of unfluted point technology<br>• Potentially preceeds or is contemporaneous with Clovis |

Table 2. 2. Significant Colonizer Sites in the Pacific Northwest (continued)

| | | | |
|---|---|---|---|
| Richey Roberts Site | ~11,600 | East Wenatchee, Washington State | • In situ Clovis Cache |
| Lind Coulee | >11,600 | Warden, Washington State | • Upland location in Upper Pleistocene alluvial sediments<br>• Large occupation area suggesting repeated use |
| Bishop spring | 11-12,000 | Quincy, Washington | • Broad variety of colonizer age artifacts<br>• Spring deposits have preserved an excellent record of plant macrofossils and bone |
| Paisley Caves | ~12,000 | Oregon | • Very early "pre-Clovis" site<br>• Human corprolites provide a direct means of dating actual human activities |

of fluted points is largely restricted to valleys, often along the terraces of extinct Pleistocene lakes (Grayson, 1993); they are rarely found in high upland contexts.

**Five Mile Rapids**

The five-mile rapids site (35WS8/WS4) near the town of The Dalles, Oregon, established some of the first radiocarbon dates supporting early Holocene archaeology for the region, (dated to 9.79 KBP Uncorrected). Artifacts range from late Holocene through Western Stemmed forms. The site appears to be a large fishing and fish processing site, based on the presence of more than 100,000 salmon remains. While fish bones are found here and at other colonizer age sites, details of fishing technologies and overall reliance on fish species are questionable. Cressman et al. (1960) report a barbed bone point with a composite harpoon from the early levels of the site. Other authors have argued that the site represents an aggregation place for naturally spawned-out fish. Butler (1990) and Butler and O'Connor (2004) argue a clear case for fishing based on the lack of heads among fish remains (they were selected either as refuse or delicacy--either way; people must have discarded them elsewhere). Geologic data is also utilized to support a cultural origin of the salmon carcasses. With this in mind, it is of note that the Buhl, Gore and Kennewick skeletons all display stable carbon isotope ratios that reflect at least some reliance on marine foodstuffs during the colonizer period.

In addition to fish, bird remains are abundant at the site, with more than 9000 curated specimens in the site assemblage. Although Erlandson and Moss (2001) question the nature of avifaunal remains at the site, Hansel-Kuehn (2003) sees clear evidence for a cultural origin, based on the presence of systematic butchery, limb-bone cylinders (reflecting selection as a food source) and the association of flaked stone tools.

Hansel-Kuehn also suggests potential for early (colonizer period) ritual use of birds at the site. Examples of avifaunal remains that represent potential ritual use during the colonizer period are present at some Pacific Northwest sites. At the Marmes rockshelter an articulated owl foot, originally found between two modified chalcedony flakes was recently buried under NAGPRA, the Native American Graves Protection

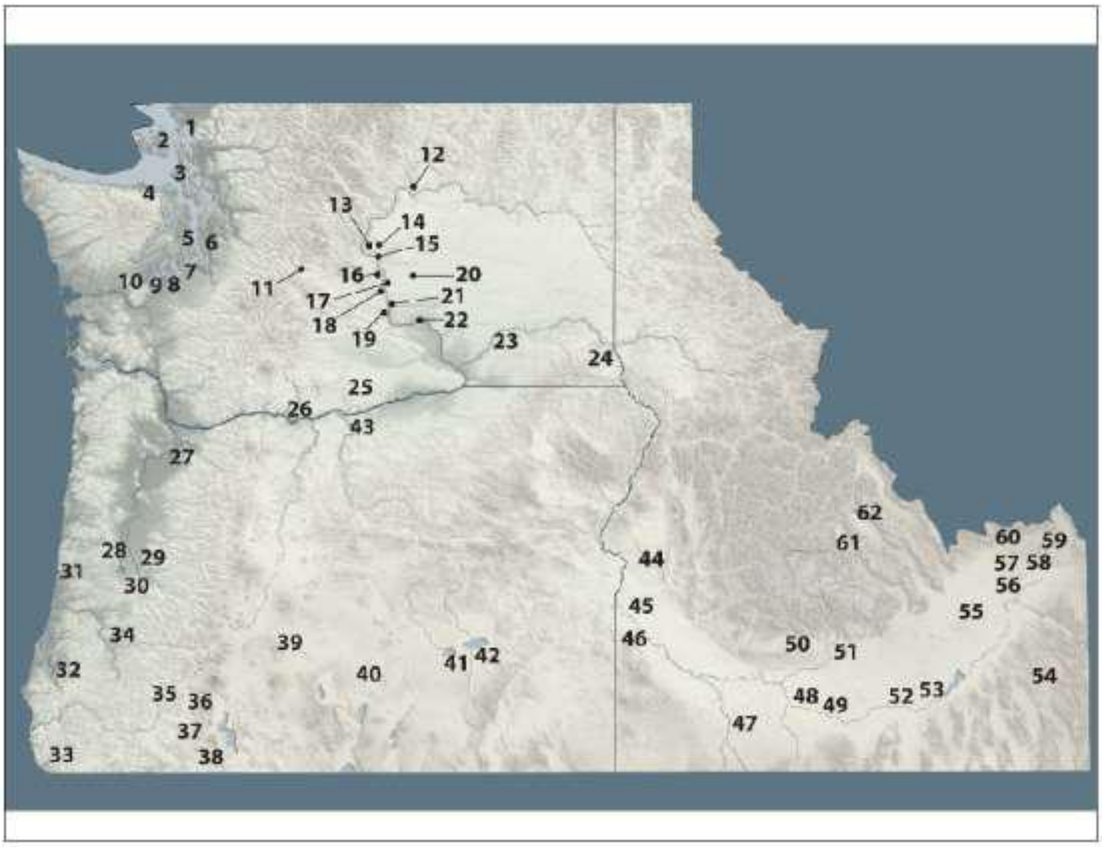


Figure 2.1 Fluted Point occurrences in the Pacific Northwest

and Repatriation Act (Fryxell and Keel 1969; Federal Register: May 12, 2010). At Charlie Lake cave two raven skeletons dating between 9.5-10.5 KBP were found in deliberate burials (Driver 1999). Cressman reported the presence of ochre with bird bones and antler artifacts in the early deposits, he hypothesized they might be related to a ceremonial complex.

A great number of bolas stones were recovered during Cressman's excavations—he attributed them to bird capture. However, Pettigrew (1990) and Aikens (1993) argue that these bolas are likely net weights for taking fish. I see no reason to believe that the two are necessarily mutually exclusive; the stones could easily serve multiple functions like many colonizer period tool forms.

Table 2.3 Fluted Point occurrences in the Pacific Northwest—Keyed to Figure 2.1 map

| ID | SITE NAME | SITE # | LOCATION | MATERIAL | TYPOLOGY | REFERENCES |
|---|---|---|---|---|---|---|
| 1 | Bellingham Pt. | none | unknown | | Fluted | Avey 1991 |
| 2 | Ayers Pond | 45SJ454 | Orcas Island | | | Schalk, Kenady and Wilson 2007 |
| 3 | Bishop's Clovis Site | 45IS112 | Oak Harbor, WA | | Clovis | Wesson 1988 |
| 4 | Manis | 45CA218 | Sequim, WA | | | Gilbow 1981 |
| 5 | Yukon Harbor | 45KP139 | Bremerton, WA area | Tachylite | Clovis | Croes et al. 2008 |
| 6 | Maple Valley (Hamilton Bog) | 45KI215 | Maple Valley, WA 100m above the Cedar River floodplain | Orange chert weathered' to dark gray | Fluted | Dunnell and Meltzer 1987 |
| 7 | Waughop Lake | none | Lakewood, WA | | Clovis | Avey and Starwich 1985 |
| 8 | Camus Clovis (Harts Lk. or Anderson Is.) | none | Lacey, WA | | Clovis | Avey 1991 |
| 9 | Olympia | none | Black Hills area west of Olympia, WA | Tachylite or basalt glass, | Clovis | Osborne 1956 |
| 10 | Chehalis | none | Chehalis River Valley | Fine-grained tan chert, | Fluted | Osborne 1956; Dunnell and Meltzer 1987 |
| 11 | Lake Cle Elum | FS01492 | Ronald, WA area | | Clovis | Carter and Hollenbeck 1986 |
| 12 | Bridgeport | none | 35 miles from Bridgeport, WA | | Clovis | Schroder 1958 |
| 13 | E.Wenatchee Rutz Clovis | none | East Wenatchee, WA | Obsidian | Clovis | Avey 1991 |
| 14 | E.Wenatchee Clovis or Richey | 45DO482 | East Wenatchee, WA | Beezley chalcedony | Clovis | Mierendorf 1987 |
| 15 | Rock Island | 45CH204 | Rock Is. Dam Columbia River, WA | Beezley chalcedony | Fluted | Valley 1975 |
| 16 | Tekison Drainage | none | West Bar/Crescent Bar, WA | Chert – gray/tan | Clovis | This study |
| 17 | None | 45KT67 | Cape Horn/West Bar/Crescent Bar, WA | Alabates chert | Folsom | Freiberg and Sharp 1994 |
| 18 | Schaake Village | 45 KT 37 | Vantage, WA area | Agate; agatized wood | Fluted | Swanson 1956 |
| 19 | Huntzinger Ranch | none | Vantage, WA | Chert – gray/yellow/ white | Folsom | Avey 1991; Browman and Munsell 1969 |
| 20 | Winchester Wasteway | 45GR161 | Ephrata, WA area | | Clovis | Moody 1978 |
| 21 | Crab Creek | none | Beverly, WA area | Obsidian | Clovis | Avey 1991 |
| 22 | Yeager Island | none | Priest Rapids Dam, WA | Beezley chalcedony | Clovis | DeJong 1948 |
| 23 | Mitchell Site | 45WW62 | Tucannon, WA | | Fluted | Hackenberger and Howes 1981 |
| 24 | Asotin | none | Asotin, WA | | Folsom | Rice 1985 |
| 25 | Kavanaugh Springs | 45KL316 | Bickelton, WA | | Fluted (Folsom?) | Kavanaugh 1985 |

Table 2.3 Fluted Point occurrences in the Pacific Northwest—Keyed to Figure 2.1 map

| ID | SITE NAME | SITE # | LOCATION | MATERIAL | TYPOLOGY | REFERENCES |
|---|---|---|---|---|---|---|
| 26 | The Dalles | none | Across from The Dalles on Wash. side | Dense, slightly glassy obsidian | Clovis | Osborne 1956 |
| 27 | Canby Clovis | none | Canby farm | white chert | Clovis | Heinz 1975; Ozbun and Fagan 1996 |
| 28 | Fern Ridge | none | Long Tom Basin | red-brown chert | Clovis | Connolly 1994 |
| 29 | Mohawk Valley | none | Mohawk gravels | black obsidian | Clovis | Allely 1975; Gerity 1960; Ozbun and Fagan 1996 |
| 30 | Cottage Grove | none | Cottage Grove | grey-banded obsidian | Folsom | Minor 1985 |
| 31 | Siltcoos | none | Is., Siltcoos Lake | red jasper | Clovis | Minor 1985 |
| 32 | Camas Valley | none | Up.Coq. R. bank | green-brown chert | Clovis | Ozbun and Fagan 1996; Wallman 1994 |
| 33 | Winchuck | 35CU176 | Winchuck R.side | green CCS | Clovis | Fagan 1990; Ozbun and Fagan 1996 |
| 34 | Winchester | none | N.Umpqua R. | red jasper | Clovis | Ozbun and Fagan 1996 |
| 35 | Seneca Clovis | 35DO634 | Up. Umpq.Basin | obsidian | Clovis | Ozbun and Fagan 1996 |
| 36 | Medco Pond | none | n. Butte Falls | mottled jasper | Clovis | LaLande and Fagan 1982 |
| 37 | Ridgeline Meadow | 35JA301 | KF/Ashland | white CCS | Clovis | Ozbun and Fagan 1996 |
| 38 | Green Springs | none | KF/Ashland hwy. | red/green CCS | Clovis | Ozbun and Fagan 1996 |
| 39 | Fort Rock | none | Ft. Rock area | tan chalcedony | fluted | Gerity 1960 |
| 40 | Dietz | 35LK1529 | Alkali Basin | obsidian | Clovis | Ozbun and Fagan 1996; Willig 1989 |
| 41 | Harney Lake | none | No. Catlow V. | basalt | fluted | Gerity 1959 |
| 42 | Malheur | none | M.L. old shore | mottled jasper | Clovis | Gerity 1960 |
| 43 | Blalock | none | 1.5 mi S, Col.R | vitreous lava | Clovis | Gerity 1960 |
| 44 | Paddock Valley Reservoir | none | West Central Idaho | | fluted | Titmus and Woods 1991 |
| 45 | Alkalai | 10OE867 | West of Boise along Snake R. | Microcrystalline silicate | Clovis | Huntley 1985 |
| 46 | Reynolds Creek | 10OE2055 | SE of 10OE867 along Snake R. | Obsidian | Folsom | Moe 1982 |
| 47 | West Clover | 10OE3197 | Along Bruneau R. ½ way to border | Microcrystalline silicate | Clovis | Druss and Druss 1986 |
| 48 | Crystal Springs | 10GG207 | Twin Falls, ID/Snake River | Microcrystalline silicate | Clovis | Murphey 1985 |
| 49 | Blue Lakes | none | Twin Falls, ID | Microcrystalline silicate | Clovis | Titmus 1988 |
| 50 | Simon Site | 10CM7 | Fairfield, ID | Microcrystalline silicate; Quartz crystal | Clovis | Butler 1963; Butler and Fitzwater 1965; Woods and Titmus 1985; Yohe and Woods 2002 |
| 51 | Timmerman Hill | none | Big Woods R. near Ketchum, ID | Obsidian | Folsom | Titmus 1985 |
| 52 | Gifford Hot Springs | none | SW of Pocatello, ID along the Snake R. | Obsidian | Folsom | Titmus and Woods 1988 |
| 53 | Lake Channel | none | SW of Pocatello, ID along the Snake R. | Microcrystalline silicate | Folsom | Campbell 1956 |
| 54 | Henry | 10CU34 | East of Pocatello, ID | Obsidian | Folsom | Butler 1980 |

Table 2.3 Fluted Point occurrences in the Pacific Northwest—Keyed to Figure 2.1 map

| ID | SITE NAME | SITE # | LOCATION | MATERIAL | TYPOLOGY | REFERENCES |
|---|---|---|---|---|---|---|
| 55 | Wasden (Owl Cave) | 10BV30 | Bonneville County near Idaho Falls, ID | Obsidian | Folsom | Miller 1982; Miller and Dort 1978 |
| 56 | South of Juniper | none | Near St. Anthony, ID | Obsidian | Folsom | Titmus and Woods 1988 |
| 57 | NJ-East | none | Near St. Anthony, ID | Microcrystalline silicate | Folsom | Titmus and Woods 1988 |
| 58 | Wright's | none | Near St. Anthony, ID | Microcrystalline silicate | Folsom | Titmus and Woods 1988 |
| 59 | NG-2 | none | Near St. Anthony, ID | Obsidian | Folsom | Titmus and Woods 1988 |
| 60 | Rockchuck Ridge | none | SE ID near MT border | Obsidian | Folsom | Titmus and Woods 1988 |
| 61 | Big Flat | none | Near Challis, ID | Microcrystalline silicate | Folsom; Clovis | Butler 1972; Titmus and Woods 1988 |
| 62 | Ellis | none | Near Challis, ID | Microcrystalline silicate | Folsom | Butler 1972 |

**Kettle Falls**

The Kettle Falls site is located on Hayes Island, in Ferry County, Washington state. The island is divided by a large gravel bar that has dissected two archaeological locales. Chance and Chance (1977, 1978, 1982, 1985) described estimated occupations at the site beginning at 9.6 KBP through the historic period. Not surprisingly, the site represents an early fishery. Over 2,000 tools were excavated from the site, primarily Windust in age, but with later cultural manifestations as well. Artifacts are made on local quartzite, but obsidian traced to the Tucker Hill source in Oregon is also present.

Potential archaeological features at the site include a linear pile of fire cracked cobbles thought to be a hearth or trough located in a dwelling, one of the earliest such features in the region. Kettle Falls appears to represent a colonizer period fishing site, similar in nature to the Rock Island Overlook and Five mile rapids, both locations of the largest fisheries on the mainstream Columbia River.

**Lind Coulee**

The site is located within the Lind Coulee wasteway near the town of Warden, Washington. It was identified by Professor George Beck of Central Washington University in 1947, who contacted Dr. Richard Daugherty and informed him of the find. Initial excavations took place in 1948 under the general direction of Daugherty; subsequent studies were undertaken by Roald Fryxell (geology) Cynthia Irwin and Ula Moody (archaeology and geoarchaeology).

Chapter 6 provides a detailed analysis of Lind Coulee site stratigraphy, but it is important to note here several details. Irwin and Moody (1978:253) defined seven periods of occupation, together comprising what Moody referred to as 36 "microstratigraphic units". Moody notes that "microstratigraphy" is a term which represents an approach to geoarchaeological excavation techniques employed by the pioneering geoarchaeologist Roald Fryxell (Moody 1978). Fryxell did not publish details of his microstratigraphic approach, and Moody does not define the concept, other than to suggest that the effects of pedogenesis, alluvial aggradation and human use of a site area may independently and/or cumulatively contribute to extremely subtle stratigraphic differentiation. Amara (1975:6), also a student of Fryxell, adds meaning to the microstratigraphic approach concept by suggesting it refers to, "…examining the finer depositional units within each separate, broad stratigraphic unit; in other words, the micro-stratigraphy." Future research efforts at reproducing correlative stratigraphic details of such subtleties, in the absence of explicit definition will be difficult at best.

Moody (1978:3) identified a key problem in the initial excavations of the site by Daugherty (reported in 1956). In deeper levels of the site, archaeological materials were cemented by pedogenic carbonate (likely Bishop/Badger Mountain geosols of Chapter 4), making excavation and delineation of stratigraphic units very difficult.

Average radiocarbon ages associated with the site hover around ~8.7 KBP. (Irwin and Moody, 1978; uncalibrated). Problems with the dating are evident however as Moody based her date by erroneously extrapolating Mt. St. Helens set J tephra that is dispersed through cultural materials at the site which actually dates ~11.6 KBP (Mullineaux, 1986; uncalibrated). Other dates are reported from the site, including two by Daugherty (1956) at 9400±940 and 8518±400 and one by Fryxell on humic acids reported as 8600±65 (Sheppard and Chatters 1976 in Irwin and Moody 1978). A bison scapula closely underlying the St. Helens J ash was dated by Moody (1978) at 12,830±1,050 (uncalibrated). This latter conformable date may suggest an older occupation of the Lind Coulee site than is recognized at present, the presence of archaeological material underlying Mt. St. Helens Set J. tephra certainly does.

In order to verify the potential early date the relative tephrochronology suggests, I attempted to obtain radiocarbon dates on 9 pieces of archaeological bone which were recovered in levels below Mt. St. Helens Set J tephra. The samples were processed at Stafford Research Labs and initially they appeared to have sufficient collagen for dating. The appearance of the bone cross-section included the presence of distinct Haversian canals on the outer portion of the bone cortex and lesser amounts adjacent to the medullary cavity (Figure 2. 2). The interiors were white and chalky whereas the regions adjacent the exterior or interior were dense, somewhat waxy and hence, containing collagen. But upon decalcification, a necessary step in the dating process, the collagen would break into increasingly smaller fragments and a significant amount went into solution (Tom Stafford, personal communication).

Artifacts at the site were interpreted by Daugherty to reflect a hunting encampment. The lithic assemblage is dominated by finished and exhausted tools; in addition to an abundance of flaking debris, formal tools include stemmed projectiles, eyed bone needles, and crescent tools (Figure 2.4). Very little evidence for on-site lithic processing is available; the near absence of stone cortex suggests that tool stone was processed off-site, likely at a workshop near the stone quarries.

Lithic raw material appears to be dominated by extremely high quality tool stone, fine-grained micro and cryptocrystalline material, primarily chalcedonies that appear similar to the Beezley Hills source, but which could be from nearly any of the Columbia River basalt interbeds (Chapter 5 below). Eight obsidian flakes were recovered from multiple excavations at Lind Coulee; I submitted all eight artifacts for X-Ray fluorescence analysis in order to determine their source. Two geochemical obsidian sources were identified among the eight obsidian artifacts that were characterized by the analyses. The locations of the site and the identified sources are shown in Figure 2.3, Chapter 5 provides specific detail on obsidian use during the colonizer period.

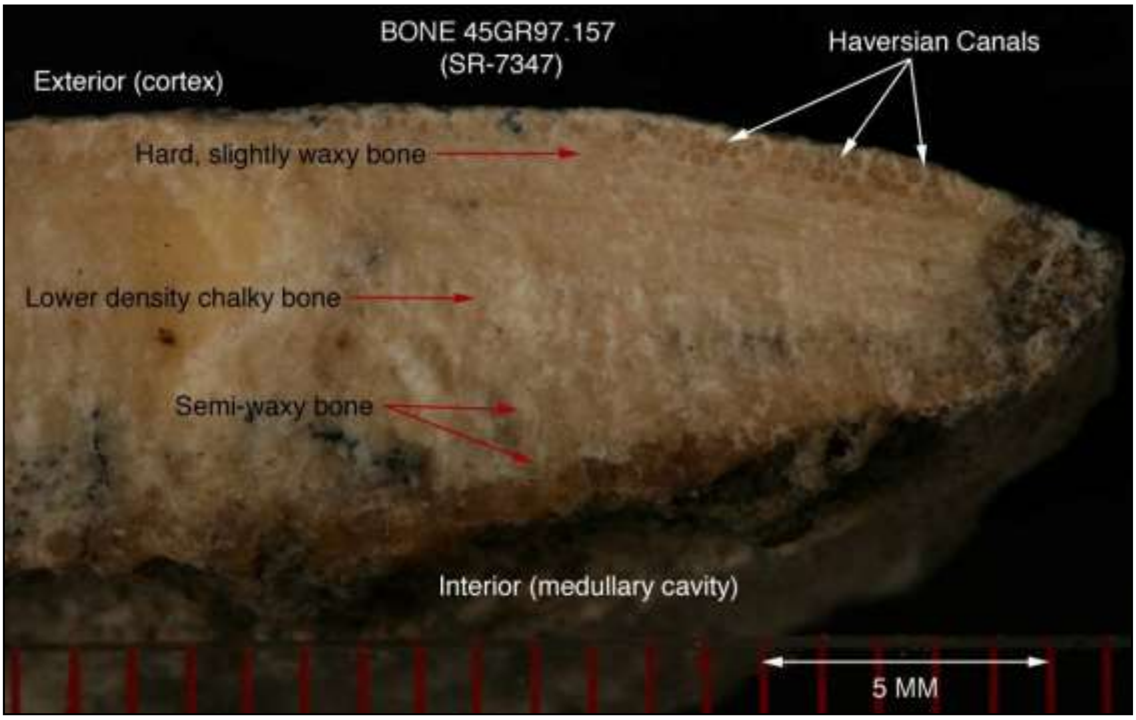

Figure 2. 2. Cross Section of Lind Coulee Archaeological Bone Suggesting Intact Bone Collagen, courtesy of Tom Stafford

Bone tools include eyed bone needles, serrated bone points, bone beads and beveled bone rods similar to other Paleoindian finds such as the Richey, Anzick and Sheaman sites (Gramly 1992; Lahren and Bonnichsen 1974; Frison and Stanford 1982). Bone tools appear to have been manufactured on site based on the amount of bone in various


Figure 2.3 Locations of the Lind Coulee Site (45-GR-97) and the sources of the analyzed artifacts.

stages of tool production. Fetal and new born bison remains suggested to Moody at least one period of site utilization during the spring. In an analysis of faunal material, Wilson (2008) was only able to identify three articulating (juvenile) phalanges, although he interprets the large number of waterfowl as supporting a spring occupation. The absence of caudal vertebrae and piles of large-mammal limb bones are interpreted by Irwin and Moody to suggest that processing of animal hides took place on site (Irwin and Moody 1978:247). Amara (1975) comes to a similar conclusion by

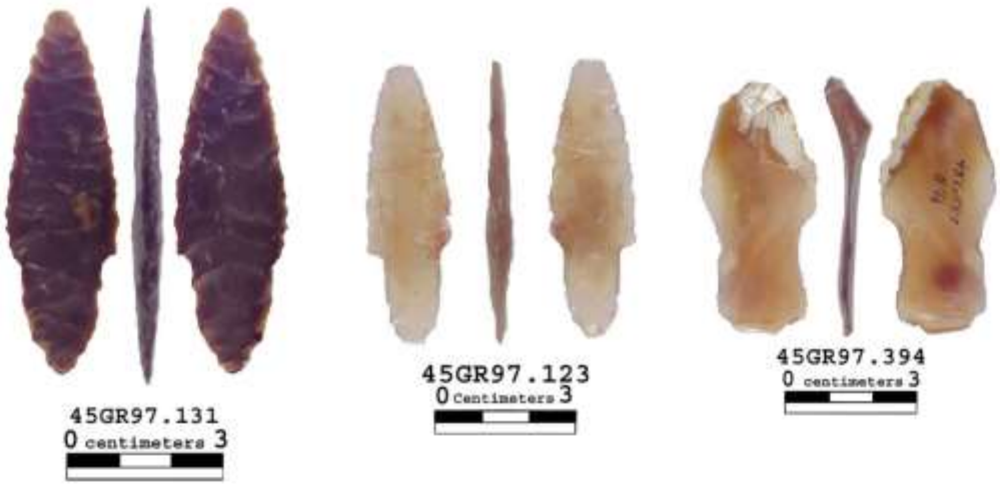


Figure 2.4 Lithic stemmed bifaces and a flake tool made on chalcedony, Lind Coulee.


Figure 2.5 Bone tools, Lind Coulee

analyzing the sedimentology of the alluvial deposits. Incipient soils formed into the stable alluvial surfaces which were also the surfaces used by site occupants. Winter/spring floods buried the stable surfaces, leaving alternating humic-rich (dark) and humic-deprived (light) zones.

**Richey-Roberts Clovis Site, East Wenatchee, Washington (45GR482)**

The Richey-Roberts site, the only known Clovis cache site with the benefit of primary context, has a complex history that is of note. The site was discovered in East Wenatchee in 1987 when an orchard worker was digging a trench for a new irrigation system. Dr. Russell Congdon, a local amateur archaeologist and former Chair of a long-dissolved association of antiquarians, the "Columbia River Archaeological Society", identified the disturbed cache as Clovis tools, Robert Meirendorf a regional, professional archaeologist confirmed the find. Professionals from across the US converged on the site to verify the find and participate in exploratory excavations. In 1988, Pete Mehringer from WSU Pullman organized a team of graduate students and professionals to undertake the first controlled excavations. On discovering the complexity of the cache and the need for further help, Mehringer proposed an expanded excavation, but Mehringer's research at the site was soon halted. In an act of incredible professional hubris, Mehringer attempted to force the land owner, Mack Richey into funding the expanded excavation, at one point suggesting that unless he provided the additional funding, he would be the "Grinch that stole Clovis" (Letter in possession of the author). Mehringer was fired nearly immediately and in 1990 Mike Gramly from the Buffalo Museum of Science resumed the work. I was fortunate to work at the site during the 1990 excavation, but disagreements with Tribal and state authorities ultimately halted the excavation before recovery of all the exposed artifacts. This final excavation ended with a mandatory 15 year moratorium on research there.

Gramly (1991, 1993) has produced the only record of artifacts recovered at the site, a monograph and an article on blood residue analysis. Mehringer published a short description related to the age of the cache (Mehringer, Waitt and Foit 1989), but after more than twenty years, no other record of his work exists. Despite these political and professional foibles, the Richey Roberts site remains the sole Clovis cache to be recovered in primary context. The artifact inventory includes 20 large bifaces, 4 blades, several flakes, 12 beveled bone rods and 14 projectile points. In terms of technology, overshot flaking is common on the bifaces.

Attempts at directly dating Bone collagen from beveled bone artifacts at the Richey-Roberts site failed, as they appear to be contaminated with recent carbon, possibly from the effects of irrigation and saturation of pesticides in the apple orchard. The Richey site assemblage is associated with tephra from Glacier Peak dating to about 11.6 KBP. (Mehringer and Foit 1990), providing a maximum limiting age that is slightly earlier than Waters and Stafford's findings.

**Bishop Spring, Washington (45GR1621)**

The Bishop Spring Site is located on the western margin of the Columbia Plateau, in Grant County, Washington. Preliminary fieldwork at the site provides evidence of multiple archaeological components ranging from Upper Pleistocene to early Holocene in age. Buried volcanic tephra and organic-rich Upper-Pleistocene and Holocene stratigraphy provide an ideal environment for chronometric and relative chronological dating of the archaeological deposits.

Temporally sensitive artifacts recovered from controlled excavation and by fortuitous collecting of local residents of the area include macroblades derived from prepared cores, blade core fragments, graving and boring isolated spur tools, as well as artifacts from later cultural manifestations of the region. Geomorphic and stratigraphic investigations provide details of the depositional setting and contribute to the overall geoarchaeological interpretation that the site represents a unique sediment and plant macrofossil trap that was utilized by early inhabitants of the Columbia Plateau.

The site is located on a structural bedrock bench – the Grand Ronde formation of the Columbia River Basalt Group – 300m above the floodplain of the Columbia River. Sedimentary stratigraphy exposed in a trench on the margin of the spring and in a single auger core reveal a continuous, uninterrupted and buried record of deposition beginning with Upper Pleistocene Missoula flood sediments, continuing through the Holocene, capped by Mt. St. Helens 1980 volcanic tephra.

Geomorphology of the location indicates that Missoula floodwaters coursed through the Columbia River Gorge and were met by more easterly floods flowing through the Quincy Basin creating classical scoured and denuded Scabland topography. Floodwater incised the upper section of high basalt cliffs overlooking the gorge, depositing a series of large pendant bars. Topographic lows located between scoured bedrock outcrops are filled with flood sediment and capped by post-flood and Holocene loess deposits. Water flowing from the spring was channeled through a bedrock constriction, creating a natural sediment trap that supported a rich biotic microhabitat, making the locale an attractive watering stop and a likely location for humans to ambush game animals.

In spring 2008 I attempted to drain the deepest portion of the spring by removing a basalt “plug” which prohibited water flow on the south end of the site. Although the water table dropped approximately 30cm, it was not enough to expose the deepest portions of the archaeology-bearing sediment that is visible in early photos when the site was initially discovered. Future work at the site will require the creation of a sump area to cut off the water source.

**Simon Clovis Cache**

In 1961 the Simon cache, found while a farmer was plowing his field near Fairfield, Idaho, was the first Clovis tool cache to be identified (Butler 1963; Butler and Fitzwater 1965; Woods and Titmus 1985). The collection is known to contain thirty-two artifacts, many of them broken by the tractor that overturned them. One artifact, the broken base of a Clovis point, was left *in situ*. Ochre covered the artifacts so thoroughly that even after washing, they remain stained. Geomorphic investigations by Haynes (1971) show that the cache was deposited on a tributary of the Deer Creek River. As is the case with other caches, no clear, modern surface markers would lend any aid in relocating the site.

The Simon site includes raw material from 14 distinct types, but few of the sourcesare known (Kilby 2008). The cache consists entirely of bifaces, ranging from a huge flake (28.5 em in maximum dimension) in the earliest stages of bifacial reduction, 14 large ovoid bifaces, 10 smaller ovoid bifaces, 4 point performs, and 7 finished points. It is clear that the cache traveled some distance as worn arrises are evident on many of the specimens. Kilby (2008) reports that this “bag wear” is minor or not present among points and preforms. and that overshot flaking is common (occurring on 66% of the bifaces).

Like the Richey cache a couple of sets of points appear to be “paired”, meaning they are nearly identical in size, shape and in the way that the fabric of the lithic raw material is incorporated into the point manufacture, with natural bands in the raw material at the same angle relative to their long axes.

**Willow Lake (45GR70)**

The Willow Lake site was initially recorded by Bruce Stallard in 1957 with follow up work by Jim Chatters in 1978. It is recorded as a late prehistoric campsite as determined by late prehistoric projectile points. Although it is now owned by the state of Washington, the site was originally a homestead of the Loan family. William Loan was raised at the homestead and provided additional information regarding the archaeology of the site. Mr. Loan has artifacts that he and his family recovered in the 1930s, including an end-thinned lanceolate biface, Windust, generalized stemmed and Haskett points and one Cascade point. It also has a variety of blade and flake tools which are commonly found in Paleoindian assemblages elsewhere.

**Winchester Wasteway (45GR156)**

The Winchester Wasteway site is located near the center of the Columbia Plateau in Grant County between George and Ephrata, Washington. The site is not reported in any comprehensive manner. It was discovered during a routine survey for the Columbia River Irrigation Project in the 1977, when an isolated, classic Clovis fluted point was found lying on the surface of a previously cultivated field. In addition to the Clovis point, a sparse lithic scatter of extremely limited extent was also recorded (Moody, 1978). The site was tested and 201 artifacts were recovered from a shallow zone within the upper 5cm of the ground surface (Table 2.). Among the artifacts recovered are two fluted points (Figure 2.6; one surface collected that is reported as an isolated find in Avey 1991) and a portion of a blade or blade-like flake (Figure 2.7).

In order to understand the extent of the site, with the assistance of a Central Washington University archaeological field school, I undertook a surface survey of the plowed agricultural field adjacent to the recorded site extent. Five people participated in the day-long survey. The site includes a very large (~60 acre) but sparse lithic scatter (< 200 flakes) in the plow zone. The chipped stone was dominated by bifacial reduction flakes. A small, heavily reworked, stemmed projectile was identified, and is the only formal tool identified during the survey. A key feature of the site is its geomorphic setting in the Quincy Basin. The site lies within the Winchester Wasteway, an irrigation overflow channel that drains the agricultural lands of the Quincy Basin into the Drumheller Channels to the south, and is similar in every way to the geomorphic setting of the Lind Coulee site 35 km to the east.

The lithic collection consists of 201 artifacts ranging from 2 fluted points, 10 complete and fragmentary bifaces, 92 pieces of shatter, 35 pressure flakes, and 59 biface reduction flakes. The surface collected fluted point is unique for the Pacific Northwest.

It is unusually broad with pronounced, excurvate margins and a very deep basal concavity. Likewise, no overshot flakes are present. In many ways, this Clovis point more closely resembles eastern fluted points of the "Debert" style (McDonald 1968), especially those from the Vail and Lamb sites, than it does most fluted points known from the Pacific Northwest.

The fluted points exhibit a waxy luster on several of the pressure flake removals, suggesting heat treatment. Similarly, 53 of the 201 specimens (26%) exhibit either waxy luster, potlids or crazing. In total, the assemblage appears to reflect biface production, possibly a workshop. All material except for a single basalt flake, is made on Beezley chalcedony whose source is no more than five miles from the Upper Pleistocene Winchester drainage. The relatively large site area and nature of the lithic assemblage indicate a possible campsite that was used repeatedly on a seasonal basis, possibly as a base for collecting raw material in the Beezley Hills just north-northwest of the locale (see Chapter 5).

**Sentinel Gap**

The Sentinel Gap, or Climbing Dunes site is an earliest Holocene site on the Yakima Firing Center lands near Vantage, Washington. The site appears to represent a campsite with a single occupation of short duration. Five radiocarbon dates on charcoal hearths cluster around 10,100 years (Galm and Gough 2008). In terms of this study the most important aspect of the site is the location: an upland Scabland setting well away from the Columbia drainage. The authors interpret the site as a winter base camp, including some of the only evidence in the region of domestic structures. Three hearths are present with flaked stone tools and artiodactyl bones lying on the living floor. A clear sequence of biface manufacture of the Haskett type is present, and bone tool preservation reveals rare examples of colonizer period hafting (clothespin style

Table 2.5 Summary of Lithic Tools and Debitage, Winchester Wasteway Assemblage

| | | | ARTIFACT TYPE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fluted Point | Complete Biface | Fragmentary Biface | Blade-like Flake | Biface Reduction Flake | Pressure/ Retouch Flake | Shatter | Other |
| RAW MATERIAL | | Basalt | | | | | | | | 1 |
| RAW MATERIAL | | P-Wood | | | | | | | 1 | |
| RAW MATERIAL | BEEZLEY | Other Chert | 1 | 1 | 1 | 1 | 16 | 12 | 30 | |
| RAW MATERIAL | BEEZLEY | Brick Red Jasper | 1 | | | | 5 | 4 | 3 | |
| RAW MATERIAL | BEEZLEY | Opaque Dark Chert | | 1 | 1 | | 13 | 8 | 20 | |
| RAW MATERIAL | BEEZLEY | Opaque Light Chert | | 2 | 4 | | 14 | 9 | 26 | |
| RAW MATERIAL | BEEZLEY | Translucent Chalcedony | | | | | 2 | 2 | 4 | |
| | | CORTEX | | 1 | | | 9 | | 8 | |
| | THERMAL | Heat Treatment (Luster) | 2 | 1 | 1 | | 7 | 7 | 9 | |
| | THERMAL | Potlid | | 1 | 1 | | 6 | 1 | 12 | |
| | THERMAL | Crazed | | 2 | | | | | 3 | |

foreshafts) tailoring (bone needles similar to those from Lind Coulee) and ornamentation (bone bead blanks).

**Horse Heaven Hills, Washington**

W. E. Fry (1969) and David Rice (1969) reported on a series of megafaunal finds in the Horse Heaven Hills, south of Kennewick, Washington. Potential association between Lind Coulee type artifacts and the extinct fauna is proposed, although no follow-up work has yet been completed, therefore, no confirming evidence has come to light.

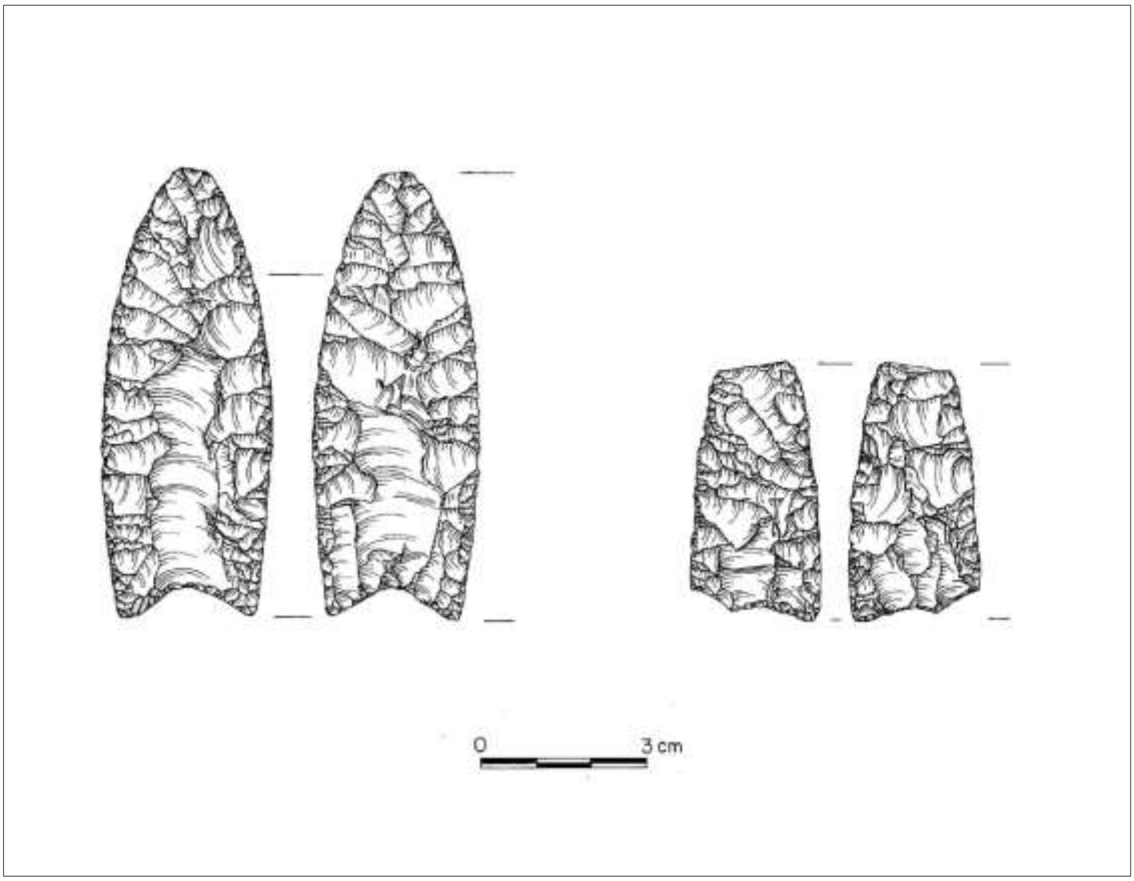


Figure 2.6 Fluted points from Winchester Wasteway. Point on the left is the original surface find. Point on the right was excavated from the upper 5cm of the site.

Nonetheless, Rice's expert opinion is that the sites discovered some 40 years ago are some of the most promising for colonizer discovery in the region. Fry investigated the upper course of Four mile Canyon, including its northern tributary canyons. The surface geology of the Horse Heaven Hills is loess. Deep drainages dating to at least the glacial maximum, dissect the loess plain. Mt. Mazama and Glacier Peak tephras are exposed in most of the canyon walls.

In total, Fry identified 20 projectile points represented at seven archaeological sites adjacent to the megafaunal remains. In addition to the early Lind Coulee projectile,

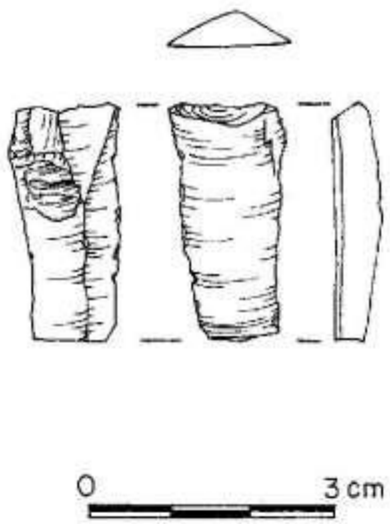


Figure 2.7 Mid-section of a blade or blade-like flake, Winchester Clovis site

several of the artifacts are at least middle Holocene in age, based on typology. Beyond this, Fry identified 31 megafaunal sites, each, of course with potential as colonizer sites, but no testing has occurred at any of the sites, to date. Extinct fauna represented at the sites include, Mammoth (21 sites), bison (5 sites), horse (3 sites) and a number of sites with deer. As I've already noted, no direct association between the extinct animals and the artifacts is yet known. Even so, the distribution of artifacts and fauna is strikingly similar to archaeological locales on the Saylor Creek Range of south-central Idaho, where more than 80 colonizer age sites are recorded within an 800 acre parcel (Eckerle and Taddie 2007). I completed a "windshield" geoarchaeological survey over the course of two days at sampled locales across the 800 acre parcel. On the Saylor Range a very clear pattern of site location and upland land use was evident. Colonizer period foragers utilized drainage-proximal environments to kill and process game animals. Groundstone artifacts at a small fraction of the sites also hinted at plant processing activities, possibly by females who accompanied men during hunting forays (see Waguespack 2005), although no such artifacts are known from Horse Heaven Hills. The local tributary drainages in southern Idaho (Brown and Pot Hole creeks) contained an alluvial fill that must have been deposited at the close of the Pleistocene, likely when the Colonizer groups were utilizing the immediately adjacent upland terraces. Alluvial cut and fill sequences from the adjacent areas along the tributary streams to the Columbia River are likely applicable to the Saylor Creek landscape, and would accommodate an upper Pleistocene to early Holocene cut and fill event(s) (See chapter 3).

**Manis Mastodon (45CA218)**

Until verification of the age of the Paisley Caves site in Oregon, the Manis site was the earliest site known archaeological site in the Pacific Northwest. The Manis locale is situated in the low foothills of the Olympic Mountains, near Sequim, Washington. The Manis mastodon bones were identified by Emanuel Manis, owner of the land, when he was excavating a pond on his property. Morgan (1985) interprets the site setting as a former ponded basin within a kettle terrane.

The site dates to at least 12.1 KBP, artifacts at the site include a bone projectile lodged in the mastodon rib, several pieces of culturally-modified bone and tusk and a bi-pointed bone artifact (Gustafson et al. 1979; Figure 2.8). Over the course of seven years of intensive excavations, no *in situ* artifacts were found at the site, and no direct evidence for a campsite was ever discovered. Nonetheless, the site setting and direct evidence of the artifacts recovered in secondary context demonstrate that the site is among the earliest in North America. In addition to the Mastodon, bones of muskrat and caribou were also discovered, many displaying cut-marks on their surfaces. Similarly, gravelly sediments underlying the ponded deposits included animal bones and charcoal, although no distinct fire-hearths were identified. Chapter 6 details the site stratigraphy, which includes both the Badger Mountain and Bishop geosols.

Figure 2.8 Bone point embedded in Mastodon rib, Manis Mastodon site (photo source: Center for the Study of the First Americans)

**Granite Point (45WT41), Washington**

Granite Point is located within the Snake River trench and was inundated in 1972 by the Lower Granite Dam. Between 1967 and 1968 the site was excavated by Washington State University Archaeological field schools, led by Roderick Sprague (1967) and Frank Leonhardy (1968). The original archaeological location, presented by Leonhardy (1970), was roughly 600 meters long and as wide as 220 meters.

Situated between the Snake River and a steep canyon wall, the site was constricted down-stream by a high alluvial fan and upstream by both an alluvial fan and a gravel point bar (Leonhardy 1970, Reid 1991).

Five cultural components represent the archaeological deposits. Component 1, represented by 408 diagnostic artifacts, dates between 10 and 9 KBP and includes stemmed Windust and lanceolate points, including large knives, burins, prismatic blades, and numerous utilized flakes, indicating at least Windust age material. Component 2, represented by 545 artifacts, dates to between 8 and 6.8 KBP and includes lanceolate Cascade points, lanceolate knives, tabular end scrapers, and edge ground cobbles, all indicative of an early Cascade phase. The later components represent middle to late Holocene archaeological cultures and will not be considered here (Leonhardy 1970, Leonhardy and Rice 1970, Reid 1991).

**Pilcher Creek, Oregon**

Located at roughly 4,000 feet above mean sea level, in the foothills of the Elkhorn Range within the Blue Mountains section of the Columbia Plateau, the proposed construction of the Pilcher Creek Dam in 1973 initiated an archaeological reconnaissance for cultural resources. Completed by Karen Canby and Bruce Womack, one prehistoric site (35UN75) was recorded as a result of this identification survey. A second professional evaluation, contracted by the Soil Conservation Service, was performed by G. James Patterson and Ben Francy in 1981, who, with limited subsurface testing, identified four prehistoric sites. As a result of this work, the Soil Conservation Service entered into a contract with the Department of Anthropology, Oregon State University to conduct further test excavations conducted under the direction of Dr. David Brauner. By the end of the first field season the significance of the Pilcher Creek Site had been realized. To mitigate effects of fluctuation of the Reservoir, in 1983, Dave Brauner returned to complete a second season of data recovery, this time with added financial support of the National Geographic Society (Brauner 1985).

The Pilcher Creek site was occupied roughly between 11.2 KBP to the late Holocene. In total, 1,138 diagnostic artifacts were recovered from the site. Fine grained volcanic raw material comprises roughly 95 percent of all recovered lithic material, including 52,630 flakes; all of this material was recovered within a roughly 100 square meter boundary of the excavations. Obsidian is the only exotic material present, making up the remainder of the stone inventory (Brauner 1985).

Based on projectile point seriation, the artifacts were divided into two components, essentially dividing the recovered diagnostic artifacts. Twenty-one lanceolate (Windust-age) points were recovered from the Pilcher Creek site. Two lanceolate specimens with concave bases were recovered and may also represent part of the Windust age assemblage. Scrapers make up the second most abundant tool type present, represented in both components, with 70 retrieved in the lower component and 79 from the upper component. Utilized flakes are the most common formed tool.

**Goldendale Site (45KL106)**

Originally recorded in 1956 by Claude Warren, the Goldendale site was re-recorded in 1976. The Goldendale site lies on a gently sloping northern base of the Columbia

Ridge, the first anticline of the Yakima Fold Belt that is north of the Columbia River. Construction of the Pacific Northwest Natural Gas Pipeline enabled the discovery of the Goldendale site in 1956. Excavation of between $62m^3$ and $75m^3$ of soil within a delineated site boundary of $292m^2$ took place in order to mitigate the gas pipleline.

The site was tested, in 1994, and deemed significant; however the antiquity of the Goldendale site has only been presented by the original investigators (Warren et. al. 1963, HRA 1994). During initial excavation a total of 277 diagnostic artifacts were recovered. Edge-ground cobbles (32), diagnostic of the Windust archaeological culture, were described at the time as identical to specimens recovered from the Monagrillo Culture of Panama, the Five Mile Rapids Site at the Dalles, Oregon, and the Red Lodge Site in Montana. Two complete projectile points were recovered from the Goldendale site, one of which being a large stemmed form very similar to Style 1 specimens reported from Lind Coulee by Daugherty in 1956. Other artifacts with shared traits between Goldendale and Lind Coulee include both thin and thick flaked side scrapers, concave scrapers, flake knives, gravers, broad oval points/knives, and choppers. The second complete point is smaller and leaf shaped, with serrated edges on the upper two-thirds of the point, a classic Cascade (archaic) point. The materials used in the manufacturing of the artifacts recovered are all available locally, including jasper, chalcedony, petrified wood, opal, quartzite, and basalt represented only by cobble choppers (Warren et. al. 1963).

**45AD23**

45AD23 is located in the Cow Creek drainage in Adams County, Washington State. The Cow Creek drainage is a Pleistocene megaflood (scabland) feature that bisects a portion of the Palouse loess formation as it flows outward to the Snake and Columbia Rivers. The site was recorded by Glen Green in 1973 and there is almost no detailed information available. The majority of the assemblage in the site record is reported to be Cascade, but local artifact collectors have obtained Western Stemmed points from the site. The reason I've included it here is due to its location within the Coulee and what I consider "credible" reports of Western Stemmed artifacts. Chapter 6 provides some detail of the terrace sequence, which supports the possibility for earlier material at the site.

**Woodhaven/Granite Falls Sites**

The Woodhaven Site is a dense prehistoric lithic site located in Snohomish County, Washington, on a high alluvial terrace, bounded by extinct Pillchuck River drainage channels to the north and south. The site was located during a compliance-based cultural resource review in 2007. The initial survey located a relatively robust scatter of flakes, pebble tools, and bipointed bifacially modified projectile points and scrapers indicative of an Olcott (Cascade) assemblage (Baldwin and Brown 2007). The Phase II exploration of the site, focused on an intense shove probe survey across the entire project area and the excavation of 1x1 analytic units to determine the horizontal and vertical limits of the site. A total of 19 1x1 analytic units and 275 shovel probes were excavated from the site by the end of the Phase II survey. Over 13,000 artifacts were collected from the Woodhaven Site, predominantly consisting of manufacture flakes and debitage. Of the more than 13,000 artifacts, around 100 were formal tools: either lanceolate points, scrapers, exhausted blade cores, unifacial adze blades, or large bifically modified cobbles. The terraced landform Woodhaven is located upon formed at the close of the Pleistocene from the combined effects of glacial isostasty and receding glacial outwash (see Chapter 6).

The majority of artifacts recovered from Woodhaven are made on andesites, and to a lesser extent, dacite. Less common material types include chert, chalcedony, quartzite, and obsidian, the latter of which were sourced to the Bear Valley region of north-central Oregon.

Lithic artifacts at 45WH417 were analyzed by Jeff Flenniken, who recognized incipient cone cortex (overlapping Hertizian cones) suggesting that the material was transported by fluvial processes. The exposed glacial till in the northern part of the site along the abandoned river channels is the likely source for the materials based on similarities in material and cortex type.

All stages of tool manufacture are present at the site, from the quarrying of material to the discarding of exhausted points. They would select material exposed in the nearby glacial outcrop, test the nodule, and bring the acceptable candidates back to camp (the flat terrace) where they would prepare blanks. Woodworking was most likely done at the site as well, evidenced by the numerous adze blades and unifacial tools which were made expediently and not transported from the camp.

**Windust Caves (45FR46)**

Pete Rice excavated a series of nine caves along the Snake River, downstream from the Palouse River mouth. The caves were brought to the attention of Dr. Richard Daugherty by a local resident, Mr. Ron Jones. Excavated between 1959 and 1961, the caves were found to hold one of the earliest records of archaeology in the region. Ultimately, the caves were flooded by the filling of the ice Harbor reservoir in 1962.

Rice referred to the artifact assemblage in the earliest levels of the caves as Tradition 1. He compared the Windust bifaces to those found at the Lind Coulee site, but he referred to the Lind Coulee bifaces as "generally larger and exhibit better workmanship than that found on the Windust specimens".

Rice presented five projectile point "traditions" within a sequence of four cultural periods. The sequence was not based on tight radiocarbon or other chronostratigraphic control; rather, it was developed by the relative stratigraphic position of the recovered artifacts within the paleoenvironmental framework of Hansen (1947) and Antevs (1948), a point which calls into question the true age of the earliest materials. The primary contribution of Rice's projectile point framework is the identification of the stemmed point tradition in the earliest levels.

**Marmes Rockshelter (45FR50)**

The Marmes Rockshelter is an upper Pleistocene to early Holocene site near the confluence of the Snake and Palouse Rivers. Radiocarbon dates from the shelter span the Holocene, the earliest is dated to 10.8 KBP (Sheppard et al, 1987). The site contains a nearly complete cultural sequence. In addition to excellent stratigraphy and well-controlled excavations, the site produced the earliest human remains in the Americas, also the earliest evidence for cremation. Krantz (1979) reported on the physical anthropology of the oldest remains and noted an important piece of information, given the new debate over early Americans. The earliest human remains termed Marmes I display shoveling of the incisors, a trait that is common to modern North American Indians. Krantz also suggested that features that appear to be cut marks on human bones at the site might represent cannibalism.

In the 1960s Marmes Rockshelter was one of the most thoroughly excavated sites with tight temporal control among archaeological sites on the Columbia Plateau. This site became a type locality for archaeological site comparisons and provided an opportunity to correlate flood sediments, inferred sedimentary processes and dated events from other rock shelters.

The death of the project geologist Roald Fryxell left Marmes Rockshelter with unanswered questions, many of the radiocarbon dates were unpublished and stratigraphic relationships were unclear. Gary Huckleberry, in Hicks et al. (2004) completed as much analysis as possible, given the time and relative disconnect from the original project.

**Thorn Thicket**

Thorn Thicket (WT36) is located along the Snake River, Washington State. The Thorn Thicket site is named for a stream that formed an alluvial fan, on the north bank of the River, where the site is located. Archaeological data recovery was initiated before the site was destroyed by construction related to relocation of the railroad. The site was inundated in 1972 by the Lower Granite Dam (Nelson 1963, Reid et. al. 1991, Sprague and Combes 1966).

Thorn Thicket was first tested and recorded by Charles M. Nelson as Wawawai I. A total of $1.3m^3$ was excavated below Mazama tephra yielding a rock feature, 35 diagnostic artifacts, 279 flakes, 66 pieces of bone and 8 pieces of shell. Among the artifacts recovered were three points identified as cascade, two were basalt and one was agate. Also a leaf-shaped basalt point with slight bilateral shouldering near the base was recovered over a meter below the Mazama ash layer. The importance of this site is recognized through the presence of the lanceolate point, suggesting an early component. Nelson (1963) also points to the comparative importance between the Thorn Thicket site and similar early assemblages across the region (Nelson 1963).

The Washington State University Archaeological Field School returned to the site, under direction of Roderick Sprague, in the summer of 1965. Three radiocarbon samples were submitted for site age determinations, but only one, 7.7 KBP, has been reported. Lanceolate points are represented by 49 basalt specimens and 20 agate bifaces, all but 8 of which were excavated from level I (Chapter 6; Bense 1970, Reid et. al. 1991, Sprague and Combes 1966).

**Kennewick Man**

The Kennewick Man site (Kman) is located in Columbia Park, Kennewick, Washington, and is dated to 8.4 KBP. Like the Buhl burial the Kman skeleton has a stable carbon isotope value indicative of a diet that included marine fish. Unlike the Buhl burial, the appearance of the Kennewick Man skull appears to differ somewhat from that of modern Native Americans, leading some to the conclusion that Kennewick

Man may reflect an early colonizer group that is unrelated to later Native American people.

The site is located on a middle Holocene alluvial terrace that may be correlated to terraces along both the Columbia and Snake rivers (cf. Chatters and Hoover, 1986; Hammatt, 1977; Chapter 3, 6). It is still unclear whether or not the site represents an intentional burial or if Kman may have floated in, being buried soon after by alluvial silts. In 1998 several research crews visited the site to undertake geoarchaeological analyses to determine the nature of the site and whether the sediments were old enough to substantiate the reported early date of the skeleton. The research teams confirmed the early Holocene age of the site (Huckleberry et al., 1998). During the course of work a light lithic scatter was identified ~100m upstream from the site and the distal and proximal ends of an apparent lanceolate biface were discovered. This lithic scatter may represent the remnants of an eroded colonizer site, one of very few along the mainstream Columbia.

**45WT2**

Nance (1966) recovered Windust phase artifacts as part of a mitigation project (at the time termed "salvage archaeology") for the planned inundation of the Lower Monumental reservoir by the US Army Corps of Engineers. The site is located at the confluence of the Palouse and Snake Rivers in Washington State just one mile downstream from the Marmes Rockshelter (Figure 2.1;Table 2.). Excavated in 1963, it is an open site that is situated on a catastrophic flood bar base with overlying alluvial and eolian sand, shoreward of the late Holocene Palouse and Snake alluvial terraces and abutting a basalt talus slope.

Nance (1966) divided the site into four areas, termed areas A-D. Areas A and B are located nearest the shore of the Palouse and Snake Rivers and appear to be arbitrarily separated by a historic period road. Area B was extensively disturbed, likely during road construction. Area C is located shoreward and Area D occupies a small area that is slightly higher in elevation, immediately adjacent to the Basalt cliff face and talus slope.

Although initial excavations included samples from areas A, C and D, the bulk of archaeological material was recovered from Area A in deposits that ranged from 3 to 7 feet deep. Nance's "Trench CL" was the primary focus of the excavations as this area contained a sequence of buried archaeology and undisturbed geologic stratigraphic context from the alluvial base to the ground surface.

Archaeological material was divided into five cultural levels, A-E, Layer A being the surface (Late Prehistoric) cultural component. Layers A-C all post-dated the Mazama eruption (7.7 KBP), and will not be considered here. Layer D was located immediately beneath the Mazama tephra, between 1-1.3m deep across Area A

Early archaeological materials from what is termed layer E, are stratigraphically underlying material dating to the early Holocene. Fragments of three projectile points were recovered in Layer E (Nance 1966). Two of the points were oval to bi-pointed bifaces and the third is a square-based point that is either a snapped stem of a larger stemmed biface or the square base of a lanceolate point (Type 7 of Nance 1966). The only other formal lithic tools included the fragment of a scraper an irregular flake knife and 8 large (undefined) stone artifacts.

Layer E contained fragmented portions of bone and highly mineralized bone, indicating relatively greater antiquity and the effects of pedogenesis on the bone. Formed bone tools in Layer E include two bone awls and a broken, barbed point fragment, similar to one recovered at Lind Coulee (Daugherty 1956:253-254).

Nance (1966) suggested two possible explanations for the early archaeology (Layer E) at 45WT2. 1. The earliest levels may represent an Old Cordilleran (early to middle Holocene bipoint) occupation, given a similar early date to Old Cordilleran (Cascade Phase) deposits at Ash Cave (7.9 KBP; Butler 1961). 2. The earliest levels are coincident in time with Windust Phase archaeology. The barbed bone point found in Layer E shares similarities with two similar points found at Lind Coulee and at the Dalles (Cressman 1960:41, 43). Given the relatively sparse information available and general lack of high-precision radiocarbon dating available at the time of the excavation, Nance remained equivocal on the nature of the early archaeology. Given the presence of an early stable soil surface in alluvium, underlying the eolian material that holds Layer E cultural materials, it is likely that the earliest archaeology discovered at 45WT2 relates to the early Holocene Badger Mountain soil time and is not part of the Upper Pleistocene archaeological record. Nonetheless, the likely presence of Bishop geosol at 45WT2 provides important information on the extent of this marker horizon in alluvial environments.

**Rock Island Overlook Site (45CH204)**

The Rock Island Overlook site is located along the Columbia River downstream of Wenatchee, WA. The site name is derived from the location of the deposit atop the large, high (A1 of Chapter 3) terrace immediately to the west of Rock Island Dam. The site was first recorded in 1974 by Cleveland, Merola and Hartmann as an open campsite containing “predominate” lithic debitage over an area 100 meters wide and ¼ mile long (Cleveland et al. 1974).

In July of 1974 excavations were initiated by Derek Valley. Based on artifacts recovered by Valley (1975), it is clear that the Rock Island Overlook site represents consistent use beginning during the late Pleistocene/early Holocene and extending through the late Holocene. The 1974 excavations led to the interpretation of CH204 as a seasonally occupied lithic workshop. The large amount of debitage, broken tools and high number of cores compared to the relatively low frequency of complete tools were the basis for this classification. Tool stone consisted of a diverse but expected range of raw materials including: jasper, obsidian, rhyolite, basalt, chalcedony, agate and petrified wood (Valley 1975).

Tools recovered from CH204 were typical of middle Columbia archaeology and the early components are clearly related to the Western Stemmed Tradition, based on stylistic comparisons to other nearby sites (Valley 1975; Lothson 1981).

Although the site was interpreted to represent the middle Holocene Cascade Phase (Valley 1975), stemmed and lanceolate points recovered from the deepest stratigraphic levels, along with Bolas stones known from other Western Stemmed sites, suggest much earlier occupation. Lothson et al. (1982) speculated that the unusually large number of square stemmed points may represent a phase pre-dating Cascade period, stratigraphic interpretations in Chapter 6 support Lothson's opinion. Although Valley does not discuss specific detail of tools or how what percentage of the assemblage was altered by heat, he does acknowledge that heat treatment was utilized at the site. Valley (1975:6) states that "old surfaces" were recognized.

**Cooper's Ferry (10IH73)**

The Cooper's Ferry site is located along the Little Salmon River in western Idaho. It was originally excavated and reported by B. Robert Butler (1969), with follow-up excavations by Loren Davis beginning in the late 1990s (Davis 2001). Butler had identified stemmed and lanceolate projectile points, and ultimately contributed to the development of the regional culture history. Davis's work confirmed the antiquity of the site, and also provided critical new chronometric dates for the Western Stemmed tradition. Table 2. presents radiometric dates associated with cultural and natural stratigraphy at Cooper's Ferry. All of the radiocarbon samples are derived from alluvial-deposited charcoal.

Archaeological material is present from the top of the section through the colonizer base. A deep pit feature dating to 11.4 KBP contained a small cache of stemmed projectiles, the first of its type among Stemmed point sites. Fieldwork is continuing at the site under the direction of Davis, but the early horizons will take years to reach, given the amount of overlying post-Pleistocene archaeology (Loren Davis, personal communication 2010).

Table 2.6 Early radiometric dates at Cooper's Ferry

| Location/Lab# | Age | Age BP | Site/Component | Material | Reference |
|---|---|---|---|---|---|
| Beta-114952 | 8,430±70 | 9406 - 9526 | 10IH73/A5 | Wood Charcoal | Davis and Schweger 2004 |
| Beta-114951 | 8,410±70 | 9400 - 9518 | 10IH73/A3 | Wood Charcoal | Davis and Schweger 2004 |
| Beta-114948 | 7,300±70 | 8032 - 8174 | 10IH73/A1/Pit | Wood Charcoal | Davis and Schweger 2004 |
| TO-7349 | 11,410±130 | 13154 - 13389 | 10IH73/A1 | Wood Charcoal | Davis and Schweger 2004 |
| TO-7346 | 8,710±120 | 9546 - 9834 | 10IH73/A1/Pit | Wood Charcoal | Davis and Schweger 2004 |
| Beta-114949 | 11,370 ±40 | 13187 - 13300 | 10IH73/A1 | Wood Charcoal | Davis and Schweger 2004 |
| To-7357 | 10,050±180 | 11283 - 11827 | 10IH73/A1 | Bone Collagen | Davis and Schweger 2004 |
| Beta-109971 | 12,020±170 | 13674 - 14092 | 10IH73/A1/Pit | Bone Collagen | Davis and Schweger 2004 |
| TO-7351 | 10,740±220 | 12394 - 12928 | SR-26-5 | Wood Charcoal | Davis and Schweger 2004 |
| TO-7352 | 11,320±80 | 13132 - 13277 | SR-26-5 | Wood Charcoal | Davis and Schweger 2004 |

**Hatwai (10NP143)**

The Hatwai site is an early through middle Holocene site located on the Clearwater River, near Lewiston, Idaho (Ames et al, 1981). The site is divided into four components, the earliest dating to the colonizer period. Hatwai I dates between 10.8 to 9.8 KBP, Hatwai II between 8.8 to 6.7 KBP. Radiocarbon dates of the two early components at the site do not correspond well with the presented cultural sequence there. For instance, while Hatwai II is noted as dating between 8.8 to 6.7 KBP, radiocarbon dating of a cultural feature within Component II dates to 9.2 KBP. Because of the apparent chronological problem and the Cascade Phase dates assigned to the recent end of component II, I will only address Hatwai I.

The Hatwai I component consists of three artifact assemblages, all of which contain classic, stemmed Windust points. Although researchers were able to differentiate between the three assemblages, they were not able to distinguish spatial or temporal patterning. Ames does not describe his methodology for dividing the assemblages, and little else is provided except for several good photos of the Windust points, and a statement that the early materials appear to fit well within known Windust artifact styles.

Table 2. presents radiometric dates associated with cultural and natural stratigraphy at Hatwai. All of the radiocarbon samples are derived from alluvial-deposited charcoal; none are directly related to cultural features.

Table 2.7 Early radiometric dates at Hatwai

| **Location/ Lab#** | **C 14 Age** | **Age BP** | **Depositional Environment/Unit** | **Material** | **Reference** |
|---|---|---|---|---|---|
| Tx-3082 | 8,820±520 | 9259 - 10589 | Early alluvium, gravel facies | Charcoal | Ames et.al 1981 |
| Tx-3266 | 8,920±1,600 | 8322 - 12153 | Early alluvium, gravel facies | Charcoal | Ames et.al 1981 |
| Tx-3265 | 9,060±1,310 | 8701 - 11848 | Early alluvium, secondary channel | Charcoal | Ames et.al 1981 |
| Tx-3265 | 9,430±230 | 10415 - 10894 | Early alluvium, secondary channel | Charcoal | Ames et.al 1981 |
| Tx-3083 | 9,560±110 | 10915 - 11093 | Early alluvium, secondary channel | Charcoal | Ames et.al 1981 |
| WSU-2440 | 10,180 ±110 | 11619 - 12074 | Early alluvium, secondary channel | Charcoal | Ames et.al 1981 |
| Tx-3081 | 9,600±1,830 | 8693 - 13179 | Early alluvium, secondary channel | Charcoal | Ames et.al 1981 |
| Tx-3158 | 10,145±870 | 10564 - 12780 | Lower bar, sand wedge, secondary channel | Charcoal | Ames et.al 1981 |
| Tx-3160 | 10,410±720 | 11187 - 12973 | Mid-bar, climbing gravel-sand foreset bedding | Charcoal | Ames et.al 1981 |
| Tx-3159 | 11,140±140 | 13143 - 13397 | Lower bar, base gravel contact | Charcoal | Ames et.al 1981 |

## Artifact Collections with early material

While colonizer archaeological *sites* are exceedingly rare, private artifact collections from across the Plateau contain colonizer *artifacts*. Windust, Lind Coulee and other Western Stemmed Tradition points are very common. Less common are Fluted Tradition artifacts. The following analysis is based on a survey of Fluted Tradition projectile points and macroblades held in 26 artifact collections, some of which are keyed to Table 2., and Figure 2.1.

Several researchers have previously report isolated fluted point finds in the region (Browman and Munsell 1969; Gramly 1992; Moody 1978; Schroder 1958). Avey (1992) summarized fluted point occurrences in Washington State, adding two isolated fluted points from the Vantage region in a section titled "oral tradition." The following describes new fluted points and the sites they were collected from in the central interior Columbia Plateau.

In total, eleven Clovis and Folsom fluted points and 1 channel flake, representing 6 fluted point sites from the central Columbia Plateau were identified in the collections (Table 2.3; Figure 2.1). In addition, new obsidian source data was gathered from 3 Clovis fluted points, 2 held in private collections and 1 point donated from a private collection to the Thomas Burke Museum, University of Washington.

## Results of the Survey

Colonizer artifacts identified or analyzed as a result of the review of artifact collections include an isolated find of a Clovis point from the ground surface at the mouth of Crab Creek (Avey 1992), a Clovis point preform in a private collection from a West Bar location, a Clovis-type point and an exhausted Clovis point from Huntzinger Bar, Folsom points (in a private collection) from 45KT67 a cave north of Vantage, a Folsom-type point from 45KT4 in the Huntzinger collection, a Clovis point as a surface find from Yeager Island on the Middle Columbia River.

## Badger Mountain

The Badger Mountain Clovis point was originally referred to by Gramly (1992), as the "largest fluted point known to science." It was identified during excavations at Richey-Roberts in 1990, when the owner, Lucille Rutz, brought it to the excavation. Les Kreis (deceased) discovered the point on Badger Mountain, near East Wenatchee, between 1946 and 1949. Mr. Kreis was a farmer who collected artifacts opportunistically as they were exposed while he tilled crops (Lucille Rutz, personal communication 1998).

The exact location that Mr. Kreis found the point is uncertain, but the present landowner knew Mr. Kreis at the time of the discovery, and he took me to the field where the point was discovered. The find-spot of the point is on top of Badger Mountain, near a large spring (Figure 2.9). The geomorphology of the site area is a broadly hummocky loess terrain, with occasional basalt outcrops. According to the landowner, Mr. Kreis searched the ground surface near the find spot for signs of other artifacts, but found nothing.

Obsidian source analysis failed to identify the source of stone for this point (Richard Hughes, personal communication 2000). Because the point is extremely large, a lithic source with abundant material would be required. It is possible that the source of stone lies in British Columbia, at a source that is not represented in the obsidian database at Geochemical Research Laboratories.

In terms of size and overall technology, this biface resembles other large Fluted points from the Richey-Roberts Cache site located less than 10 miles to the south. As with several of the Richey points, this point has pronounced, isolated platforms along the biface margin, creating a "scalloped" appearance (Figure 2.10). Like many of the bifaces in the Richey collection, this is a large bifacial core. Arrises on both faces are extremely worn down, likely from long-distance transport in a bag of similar tools.

Figure 2.9 Overview photo of Badger Mountain Clovis find-spot, East Wenatchee, Washington.

Figure 2.10 Fluted Point from Badger Mountain. Reduced by 30%

## Beverly

Avey (1992) described an obsidian Clovis point from Beverly. The point was surface collected along Crab Creek, by Mr. Don McLardy, a historian at Highline Community

College. Results of obsidian source analysis show that the obsidian came from Horsehead Mountain, Oregon, located ca. 10 km. southeast of the town of Wagontire in Harney County, Oregon (Figure 2.11). The Crab Creek drainage contains classical scabland topography and a sedimentary sequence that includes upper Pleistocene stratigraphy (see discussion of scabland sediment sequence Chapter 3).

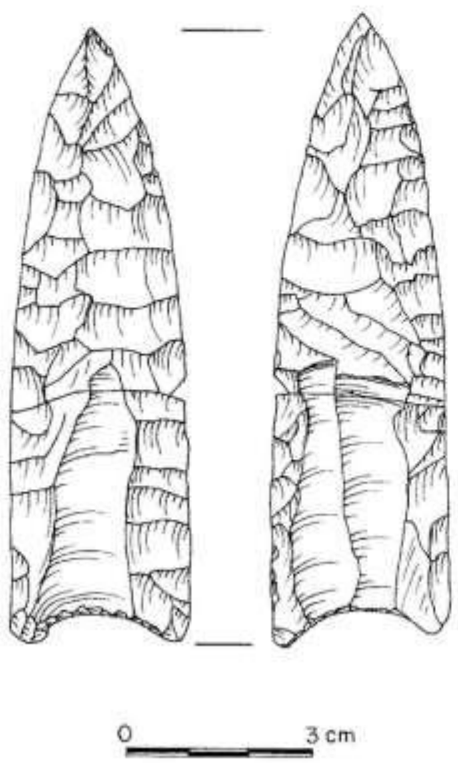


Figure 2.11 Fluted Point from Beverly, Washington

**Earl Simmons' Unknown Site**

Earl Simmons collected an obsidian Clovis point from an unknown site. Although the location of the find is unknown, two factors indicate that the point comes from the Columbia Plateau: Mr. Simmons restricted his collecting to the general vicinity of Priest Rapids to Trinidad, and he did not buy, trade, or sell artifacts (from Simmon's personal diaries held at the Wanapum Museum Repository, Wanapum Dam).

The point is a classical Clovis point type with a regular, biconvex cross-section and heavy pressure retouch along the blade margins. The point shows multiple flute scars on one face and a single, massive flute scar on the opposite face. An impact fracture has removed the tip of the point, as well as two-thirds of one blade margin. The base of the point is heavily ground, and the impact fracture ends at the maximal extent of grinding, probably the point where it was hafted to a foreshaft. Obsidian source analysis conducted by Richard Hughes indicates that the source of obsidian is the Glass Butte in central Oregon (Figure 2. 12; Richard Hughes, personal communication 1999).


Figure 2. 12 Simmons Clovis point, central Washington State

**Huntzinger Ranch**

Three fluted points were collected at the Huntzinger Ranch near Vantage. All three points are displayed in artifact frames, and could not be removed for measurement or detailed analysis of manufacture. The points were collected from the Huntzinger Ranch by Vi Kiley between 1945 and 1968. The first is a classical Folsom-type, approximately 1.25 inches long. This point was made from an unidentified mottled gray chert. The second fluted point is a Clovis type. It is approximately 3.5 inches long, and made from a gray/white chert. The third is an exhausted Clovis point approximately 1.25 inches long and made from a yellow-tan chert.

The points are said to have come from an eroding bank along the river high-water mark. The former high water mark at the site lies on the margin of the Priest Rapids reservoir. Sediments eroding into the bank along this stretch of river are A1 flood sediments, not Holocene alluvium. Although I did not observe artifacts eroding from the deposits, this stratigraphic setting supports the claim of a Pleistocene archaeological site there.

**Rock Island**

The Rock Island Clovis point was one of several collected in the 1920s on Rock Island, 8 miles southeast of Wenatchee. Artifacts that are diagnostic of the late prehistoric and historical periods dominate the archaeology of the Rock Island. Artifacts that are diagnostic of earlier cultures are restricted to a few isolated finds, and no Clovis site is recorded for the Island. Aerial photos from the 1930s indicate very little surface sediment on the island to preserve a buried Paleoindian site. A small pithouse village was excavated by the Columbia River Archaeological Society under the direction of F.S. Hall of the Burke Museum in the 1920s, and additional Clovis points are rumored to exist from the excavations (Russel Congdon, personal communication, 2000). At 1.8 inches long, this is a relatively small fluted point. The material is a high quality translucent orange and white chalcedony (Beezley chalcedony, Chapter 5), similar to material used by makers of the Clovis point from Yeager Island (see below). The point is heavily reworked, displaying only remnants of a flute and numerous small pressure retouch flakes along both margins. Given the relative lack of intact stratigraphy at the island, it is possible that this represents an artifact curated by late prehistoric peoples and left on the island. Alternatively, certainly given that other Clovis points are rumored to exist, there may be a small remnant late Pleistocene sediment at the now inundated Island.

**45KT67**

Shortly before the inundation of the Wanapum reservoir, Dr. Ken Gudgel from Spokane, with his family and several friends, excavated the Cave site (45KT67). The results of his excavations include 4 classic Folsom-type points. While a single Folsom point has been recorded in Washington State across the Columbia River from the Dalles (Osborne 1956), the Folsom point from the Huntzinger collection is the only one known from the Columbia Plateau. The site is considered to be exhausted by private collectors (Susan Freiburg, personal communication 1999), but further testing at the site should take place to confirm or deny the presence of Folsom-age archaeology.

**West Bar**

In a private artifact collection in Yakima, I discovered a channel flake and a fragment from the base of a Clovis point preform broken by an overshot flute termination. The collector reported that the finds came from a site at the mouth of the Tekison drainage at the downstream end of West Bar in Kittitas County, Washington. The collector and her husband were actively digging at sites on the West Bar for 10 years, between 1953 and 1963, during construction of the Wanapum Dam.

The broken Clovis base fragment is made of a variegated gray and tan chert (Figure 2.13). One face displays an overshot flute termination that resulted in the failure of the perform. The opposite face displays large overshot reduction flakes, nearly extending across the face of the preform. The base is heavily ground and a well-prepared remnant platform for final fluting is evident. The Channel flake is 1.75 inches long and made of a brick-red jasper. While it is not known exactly where the pieces were found, the only recorded open site at the mouth of the Tekison Creek is 45KT65. West Bar is a large point bar that was catastrophically reworked by late Pleistocene mainstream Columbia River valley glacial floods, probably after the eruption of Glacier Peak ~11.6 KBP (see Gough, 1997 for discussion of uppermost Pleistocene mainstream Columbia flooding).


Figure 2.13 Late-stage (failed) fluted preform, West Bar, Washington State

## Yeager Island

The Yeager Island site lies several miles south to southeast of the Priest Rapids Dam in central Washington state. Based on projectile point typology, the island includes materials representing all of the regional projectile point styles beginning with Western Stemmed and Fluted types.

Private artifact collectors have exploited the Island since at least the turn of the century (Adam East, unpublished journals held at the Adam East Museum and Arts center, Moses Lake, Washington). In the spring of 1948, an unusually large flood scoured the surface of the Island, exposing archaeological deposits there. Mr. Rudy DeJong, a collector from Richland and employee of the Hanford Nuclear site, was collecting artifacts on the Island just after the flood when he found the Yeager Clovis point (Figure 2.14).

The point is made of high-quality orange-tan Beezley chalcedony, and displays a fully transverse overshot percussion flaking style, where one flake results in the removal of a portion of the opposite blade margin. The point is finished with a series of pressure retouch flakes. This flaking style is widely noted on other Clovis points of the "Western" tradition and is very similar to points from the Richey Clovis site 25 miles to the north.

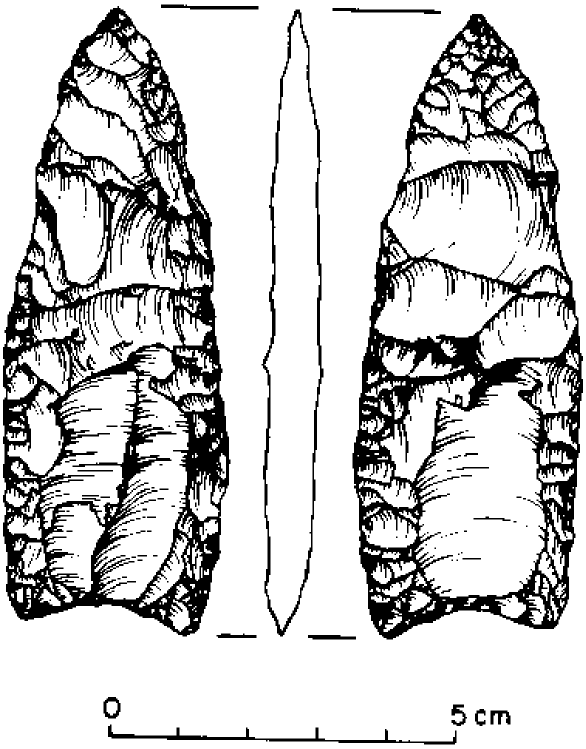


Figure 2.14 Clovis Point Surface Find from Yeager Island

# CHAPTER 3
# LANDSCAPE CONTEXT FOR COLONIZATION: AN OVERVIEW AND APPLICATION OF UPPER PLEISTOCENE GEOLOGY

## Introduction

Colonizer period archaeology on the Columbia plateau may only exist in locations that contain sediments of appropriate age and that are conducive to burial, preservation and discovery. These are fundamentally limiting factors, and it should be no surprise that upper Pleistocene archaeological sites are only sparsely recorded in the Pacific Northwest.

The application of geologic methods to archaeological research in the region has roots that reach back to lay and professional work in the early years of the 1900s. While the earliest professional archaeological research in the Columbia Plateau took place at the turn of the century (Smith 1910), except for a cursory field survey and data recovery excavation (Krieger 1927), until the 1950s, professional research was relatively stagnant. The intervening years saw the rapid progress of private artifact collectors scouring the banks of the Columbia River for relics (Figure 3.1). Smith (1910) had little to no apparent theoretical foundation when he began his inquiries, and based on his descriptive work, no apparent concept of or interest in stratigraphic principles or deep time. Smith's report is focused almost entirely on descriptive accounts of artifacts from private collections; archaeological sites were only briefly examined as they were fortuitously encountered. What was lacking during this period was the development of a chronological framework for the regional prehistory. Local artifact collectors were extremely active during this time, and their methods varied little from professional workers of the day, with a key exception; their investigations, at least in part, were based on an understanding and application of stratigraphic principles (Russell Congdon, personal communication 1996).

Figure 3.1 Members of the Columbia River Archaeological Society on the Columbia River, Washington State, ca. 1930

**The role of Antiquarianism**

One of the few, and certainly the earliest, known organized group of local antiquarians was the Columbia River Archaeological Society, based in Wenatchee, Washington. While numerous artifact collectors from Wenatchee were active during the first two decades of the century, they had no means of communicating their discoveries. Realizing this, on Tuesday, October 5, 1920, several individuals met at the Peter Pan Cafe in Wenatchee to organize a society to:

> "promote social and fraternal relations among the working archaeologists of the Columbia River Region; to promote interest in the scientific study of man and his habits within the region mentioned; and to maintain such agencies, whether of club house, museum, library, or bulletin, as appear necessary to those ends."(R.T. Congdon, 1920)

Thus began the Columbia River Archaeological Society. Following dinner the group reconvened at the home of Dr. R. T. Congdon for further discussion of the formal society. On Thursday, October 14, 1920, the members adopted the By-Laws of the Society, made F. S. Hall, Director of the State Museum at the University of

Washington a member (without payment of regular dues), and adopted an arrowhead as the emblem of the Society.[1]

The research interests of Society members varied greatly, but given the demographic of the group which leaned heavily towards the medical profession, interest in origins of the regional prehistoric populations clearly rose to the surface. In 1923, while compiling his field notes, member Adam East recorded a remarkably enlightened observation regarding Colonizer archaeology:

> Three years ago a few of us got together and organized what we call the Columbia River Archaeological Society. We now have 35 very live members, and we are getting somewhere. We believe in a few years we will be able to establish the fact that the Columbia River was a path in the migration from Asia to the South, and before the people of the Yukatan built their wonderful temples and pyramids, this Columbia region was peopled. We are going to establish the fact if possible that this is the oldest peopled country of the North American Continent (East 1923).

The Society conducted archaeological work for the next 21 years, hosting many guest speakers, including Roy Chapman Andrews, the model for the movie character "Indiana Jones", and Dr. Ales Hrdlicka, the Smithsonian biological anthropologist (Figure 3.2). Hrdlicka began corresponding with members of the society after reading a journal article by society member Dr. R.T. Congdon in the Journal of Bone and Joint Surgery, discussing the topic of *Spondylosis Thesis* in prehistoric populations, a condition that results from failure of fusion of the last segments of the spine (Congdon 1932). Congdon and other physicians collected human remains for study, many of which were given to them by patients in exchange for healthcare. Through their correspondence, Hrdlicka became aware of a site along the middle Columbia River with three deeply stratified burial levels which, based on their geologic situation, were considered to hold particularly ancient remains. The site is located on a high Pleistocene terrace overlooking the Columbia River. Although the archaeological material and human remains recovered by the Society with Hrdlicka are thousands of years old, based on association with time-diagnostic bifacial tools, they date to the late Holocene period. The important point to be made here is that people were clearly applying stratigraphic principles in search of early archaeology during the 1920s and 30s, a practice that was not consistently applied by regional professionals until decades later with the initial discovery of early man on the Columbia Plateau.

**Middle Century Academic Research**

Earl Swanson may be the earliest professional archaeologist in the Pacific Northwest Region to receive formal training in Quaternary geological methods. As an undergraduate at the University of Arizona at Tucson he took coursework from Ernst Antevs and Kirk Bryan who were building the classical geochronological sequences in support of climate change studies in the American Southwest (Antevs 1948).

[1] Routinely making enemies with Society members by not including them in his excavations and by criticizing their excavations, Professor Hall was only involved with the Society for a short time (Russell Congdon, personal communication 1996.)

Swanson's dissertation work at Cedar Cave on the Columbia River (Swanson 1956) is the earliest formal attempt to tie the buried archaeology to periods of climate

Figure 3.2 Dr. Ales Hrdlicka (ca. 1930) at the site of a late middle Holocene cemetery with deep stratigraphic profiles on the middle Columbia River, Washington State.

change (Figure 3.3). When Swanson completed his dissertation at the University of Washington in 1956 he secured a post-doctoral fellowship for study at the University of London, Institute of Archaeology in 1957. In London, he was strongly influenced by Dr. Frederick Zeuner, a geologist who pioneered European studies in dating and chronology of Pleistocene environments. Zeuner's book, Dating the Past:An Introduction to Geochronology (1946), was a classic at the time. Upon his return to the US in 1958 Swanson took an archaeology position at the Idaho State College Museum and inspired opportunities for field archaeology in the region (David Rice, personal communication 2010).

Swanson published the results of his dissertation research in 1962, reflecting his more environment-oriented focus of developing a regional culture chronology tied to the local time-stratigraphic chronology. His over-riding desire was to identify the emergence of the historic "Plateau pattern," based on the ethnographic work of Verne Ray in 1933. This became the focus of research in the region through the 1950s and into the 1960s. While searching for sites representing this ethnographic pattern, Swanson was the first to suggest that archaeological materials in the Vantage region should be viewed from within a geologic context, rather than from the point of view of the contemporary cultural setting (Ray's work). This geology-oriented approach was a major theoretical advance for archaeological work in the Pacific Northwest.

While Swanson was establishing a new research program at the University of Idaho, the American River Basin surveys, sponsored by the US federal government between 1946-1969, were initiated. While conducting the Columbia River portion of the National River Basin Surveys, Dr. Richard Daugherty, professor of Anthropology at Washington State University, was alerted to an archaeological site with apparent deep time depth by Dr. George Beck of the Department of Geology at the State Normal School (now Central Washington University in Ellensburg, Washington). Dr. Beck had identified an extinct form of Bison and associated artifacts eroding from alluvial deposits on the floor of Lind Coulee in the central portion of Washington State.

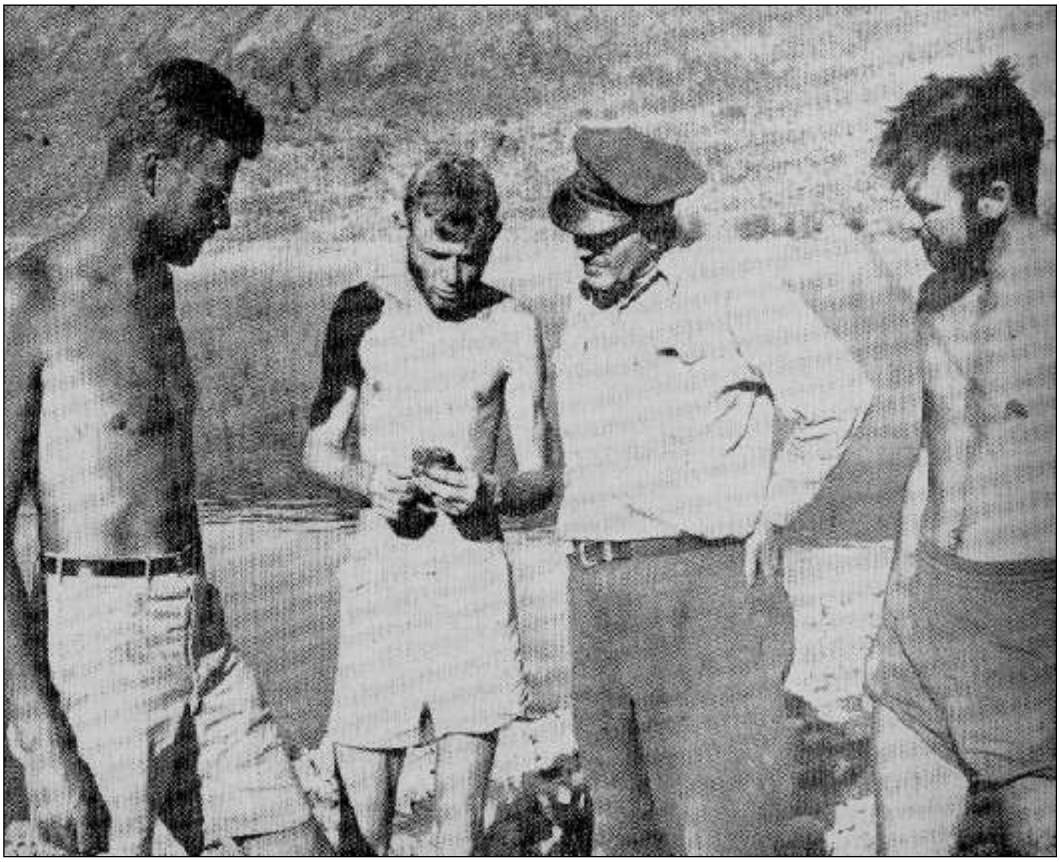

Figure 3.3 Earl Swanson and Artifact collector Tom Stockdale on the Columbia River (ca. 1950) near Swanson's dissertation site, Vantage, WA. Clipping from unknown newspaper, Russell Congdon collection.

Recognizing the potential significance of the discovery, Dr. Daugherty initiated research there which eventually led to multiple field seasons of targeted investigation. It is fair to say that the discovery of the Lind Coulee site "dropped the bottom" out of the recognized regional archaeological sequence—although a fundamental misinterpretation of the overall site geologic sequence by subsequent researchers may have contributed to an improper understanding of the actual time depth of humans in the Pacific Northwest that is only now becoming apparent (see discussion in Chapter 2).

In order to conduct archaeological research in what Daugherty considered to be a rigorous and thorough manner, he recognized the need for strong interdisciplinary cooperation. As Chair of the Department of Anthropology, he hired a staff with complementary skill sets and research interests in Quaternary science.

Among the people hired was Roald Fryxell, a Quaternary geologist and soil scientist with strong interest in the application of geologic principals to archaeological research. Dr. Fryxell conducted research at Lind Coulee, Marmes Rockshelter and other prominent archaeological sites, until his premature death in 1974. In the following years, a handful of Fryxell's students and other researchers have pursued studies with a geoarchaeological focus, or on Colonizer period archaeology. Many of these researchers, like Fryxell, have also reached untimely deaths, normally during what would otherwise be the earlier part of their careers: Earl Swanson (1975), Henry Irwin (1977), Jonathan Davis (1990) and Judith Willig (1999) among others. Although a handful of excellent geoarchaeologists work in the region today (Jerry Galm and Stan Gough, Eastern Washington University; Loren Davis, University of Oregon and Julie Stein, University of Washington) and practice applied archaeological geology, conveying its principles to their students, it is impossible to ignore the fact that progress in our understanding of key Quaternary geologic sequences in the Pacific Northwest region has suffered with the loss of these researchers.

While an applied geologic approach to archaeological research in the Pacific Northwest is not yet broadly utilized, recent examples of applied archaeological geology include Chatters and Hoover, (1992) who apply the main-stream Columbia River alluvial chronology to local archaeological sites, Galm et al. (2000), who developed the alluvial chronology of small tributaries to the Columbia River with a goal of applying the research to archaeological sites there, Huckleberry et al. (2003), who present recent, targeted geoarchaeological research, Davis (2003, 2004, 2006: with Charles Schweger) and his students, who are applying archaeological geology to sites in the Pacific Northwest and the greater Cordilleran, and Stein (1992, 2001: with William Farrand), with a focus on coastal midden stratigraphy and applied sedimentology. In the field of Cultural Resources Management, geologic methods have recently been used to develop a predictive model for locating archaeological sites across Washington State, a land area roughly three-quarters the size of the United Kingdom (Lenz et al. 2009).

Few peer-reviewed, published sources of detailed data relating to the very recent archaeological geology of the Pacific Northwest region exist. Much of the Uppermost Pleistocene and Holocene geology is developed in thesis and dissertation work associated with regional universities and through the extremely gray body of literature related to Cultural Resources Management (Baker 1987; Fecht et. al, 1985; Mierendorf, 1981; Huckleberry et al, 1998; Wakeley, et. al, 1998; Galm and Gough, 2000). Quaternary scientists in non-archaeological fields have developed a rich body of work that can be applied to the regional archaeological research; the present work is based on supporting research that is by and large from these non-archaeological fields. The following discussions are intended to establish the baseline research in a variety of sub disciplines of Quaternary science with direct bearing on locating and interpreting Colonizer archaeology.

## Paleoecology

Mehringer (1985) summarized pollen records for the Columbia Plateau. The following discussion is summarized from data presented in Mehringer (1985), Chatters (1992, 1995b). The late glacial and immediate post-glacial environment, spanning the period from 13 to 10 KBP, was characterized by a cooler and moister climate than that of today; although in some localized areas the climate was cooler and drier. Sagebrush and grasses, characteristic of a mesic cold steppe or tundra environment, dominate the vegetation spectrum of the immediate post-glacial period. Sagebrush steppe environments flourish where precipitation is primarily winter dominant. Low pollen counts in the immediate post-glacial period suggest limited arboreal vegetation especially during the Younger Dryas (ca. 11 to 10 KBP). Beginning about 10,000 years ago, the pollen records indicate an expansion of Ponderosa and lodgepole pines as well as an increase in spruce, birch, and willow, indicating that warmer and wetter conditions were developing. For this time period, steppe communities decrease in abundance and range probably due to increased moisture associated with the warming trend that immediately followed the Younger Dryas.

Maximum aridity for the Pacific Northwest region is estimated to have occurred between 10-8 KBP, represented in the geologic record by development of the calcic Badger Mountain Geosol (Chapter 4; Thompson et al. 1993). Sometime after 9 KBP, pollen records indicate a warmer and drier climatic regime based on the expansion of xeric plant species and an increase in sagebrush and grass communities (Mehringer 1985). The pollen record data from the surrounding areas suggest that the shrub-dominated steppe communities extended even into the mountains surrounding the Columbia Plateau (Mehringer 1985). The expansion of xeric communities into mountainous areas suggests a decrease of up to 40 percent of available moisture than that of today (Chatters 1995). Columbia River beaches and river bars, where well-drained sediments predominate, were likely dominated by sagebrush and grass species because of gravel-rich, well-drained sediments whereas riparian vegetation was restricted to poorly drained sediment environments such as Crab and Cow Creeks and the Palouse drainage systems (Huckleberry 2003).

## Middle to Late Holocene

The climate cooled by 6.5 KBP and effective moisture increased abruptly at 5.4 KBP. Effective available moisture appears to increase between about 4.4 KBP and 4.1 KBP as another abrupt cool and wet trend was initiated, lasting until approximately 2.8 KBP; however, flooding became less frequent and less severe, at least in the Columbia River system (Chatters 1998). In areas such as Wildcat Lake, grass cover expanded also indicating a return to more mesic climate conditions (Mehringer 1985). Mixed conifer forests, probably dominated by pines, appear on the eastern edge of the Columbia Basin (Barnosky 1985). Pollen records between 4.4 and 2.7 KBP are marked by a series of cool-wet fluctuations and a general decrease in temperatures (Galm 1994). The alluvial records suggest warm weather with frequent flooding until 3.9 KBP when a period of stability, resulting in formation of the Willow Lake Paleosol and terracing along many of the regional drainages (Chatters and Hoover 1992; Chatters 1995).

Since about 2.5 KBP, climatic conditions are generally similar to that of today with a slightly warmer and drier environment than the preceding period. A spread of sagebrush and grass up the Columbia River Valley produced an arid vegetation pattern remarked on during the early Euro-American contact period (Galm 1994). Roughly one thousand years ago severe floods occurred, but drought took hold at approximately 1.4 KBP and the highest floods ended (Chatters 1998).

After the establishment of cattle ranching, around 1860 regional streams deeply incised their floodplains. Timing of the incision is based on dendrochronologies of large trees in historic alluvial cuts that I have investigated. While the data is thin (n=20 trees), it is possible to establish a relative, minimum age of recent downcutting, based on the location of the trees growing in the side wall of the alluvial cuts. As of the years 2000-2001, when I cored the trees, their average age was 68 years, suggesting a window of time for the base level change that led to the downcutting between roughly 1860 (the initial cattle ranches established in the region) and 1930 (the average age of rooting of trees in the tributary banks.

**Glacial Advances**

At the glacial maximum the Cordilleran ice sheet crossed the present location of the Canadian border, emplacing glacial deposits along the northern portion of Washington State as far south as the Puget Lowlands in western Washington and south through the Okanogan valley in eastern Washington State. The ice sheet entered the northern portion of Washington State at least five times until finally retreating approximately 13,000 years ago, roughly the same time that we begin to see the earliest archaeological sites in the Pacific Northwest. The relationship between these continental glacial deposits and archaeological sites is poorly understood at this time. Given the recent find at Paisley Caves in Oregon of archaeological material dating to approximately 14 KBP and the known age of the Manis Mastadon site on the Olympic Peninsula at 12.1 KBP, we should anticipate several types of sites related to glacial deposits. These may include ice-marginal sites; sites related to ice-marginal lakes, sites adjacent to paleolakes that formed as a result of the glacial melt and sites that are marginal to glacio-fluvial alluvium and deltas which filled valley floors as glaciers melted (Figure 3.5).

Loading of the Cordilleran ice sheet caused subsidence of the sediment and bedrock underlying the Puget Sound to the west of the Cascade Range. Isostatic rebound has occurred there since the close of the ice-age, resulting in large tracts of land that were formerly next to Pleistocene waterways now located hundreds of feet above and several miles from the modern Puget lowland (see discussion in alluvial section).

Stratigraphic relationships, geomorphology and radiocarbon age dating indicate that the Vashon continental ice margin was a complex boundary at the general time of colonization, during ice recession. This dynamic ice margin is the result of the interplay between glaciomarine, glaciolacustrine, ground and stagnant ice dynamics. For example, the environment likely resulted in stranded ice in some adjacent uplands and ice berg ice marine waters in other environments. Elsewhere, some ice tongues in the foothills were likely adjacent to ice free ridges resulting in a distinctly hummocky, indented terrestrial environment. The lakes which formed at the interface of the ice margin were resource rich zones which were available to colonizer populations. After final recession, most of the large river valleys which drained into the Puget lowland held very large lakes that would have been similarly attractive to early people (Lenz et al. 2008).

The last Pleistocene glacial advance west of the Cascade Range occurred during the Fraser Glaciation. The Fraser Glaciation began at roughly 30 KBP with the accumulation of alpine glaciers in the mountain ranges of coastal British Columbia and in the Olympic and Cascade ranges of Washington State. The Cordilleran Ice Sheet expanded into northwestern Washington from the Fraser lowlands at about 18.8 KBP (Booth et al. 2003, Porter and Swanson 1998). As the ice sheet encroached upon the Olympic Mountain range from the north, it bifurcated into two lobes. The San Juan Lobe formed to the west, through the Strait of Juan de Fuca, while the Puget Lobe flowed south into the Puget Lowland between the Olympic Mountain Range and the

Figure 3.4 Glacio-fluvial delta deposit unconformably overlying Colonizer period beach sands and gravels in upland environment, Camano Island, Washington.

Cascade Mountain Range. The Puget lobe covered the Seattle area at 14.5 KBP and reached its southernmost extension by 14 KBP, 15 miles south of the city of Olympia. The lobe began retreating just after reaching its maximum and it had receded north of Seattle by approximately 13.6 KBP (Booth et al. 2003, Porter and Swanson 1998).

The Fraser Glaciation is divided into four regional stades. The Evan’s Creek stade was a phase of alpine glacial advance in the Cascade and Olympic Mountain Ranges as well as in the coastal mountain ranges of British Columbia (Armstrong et al. 1965, Crandell

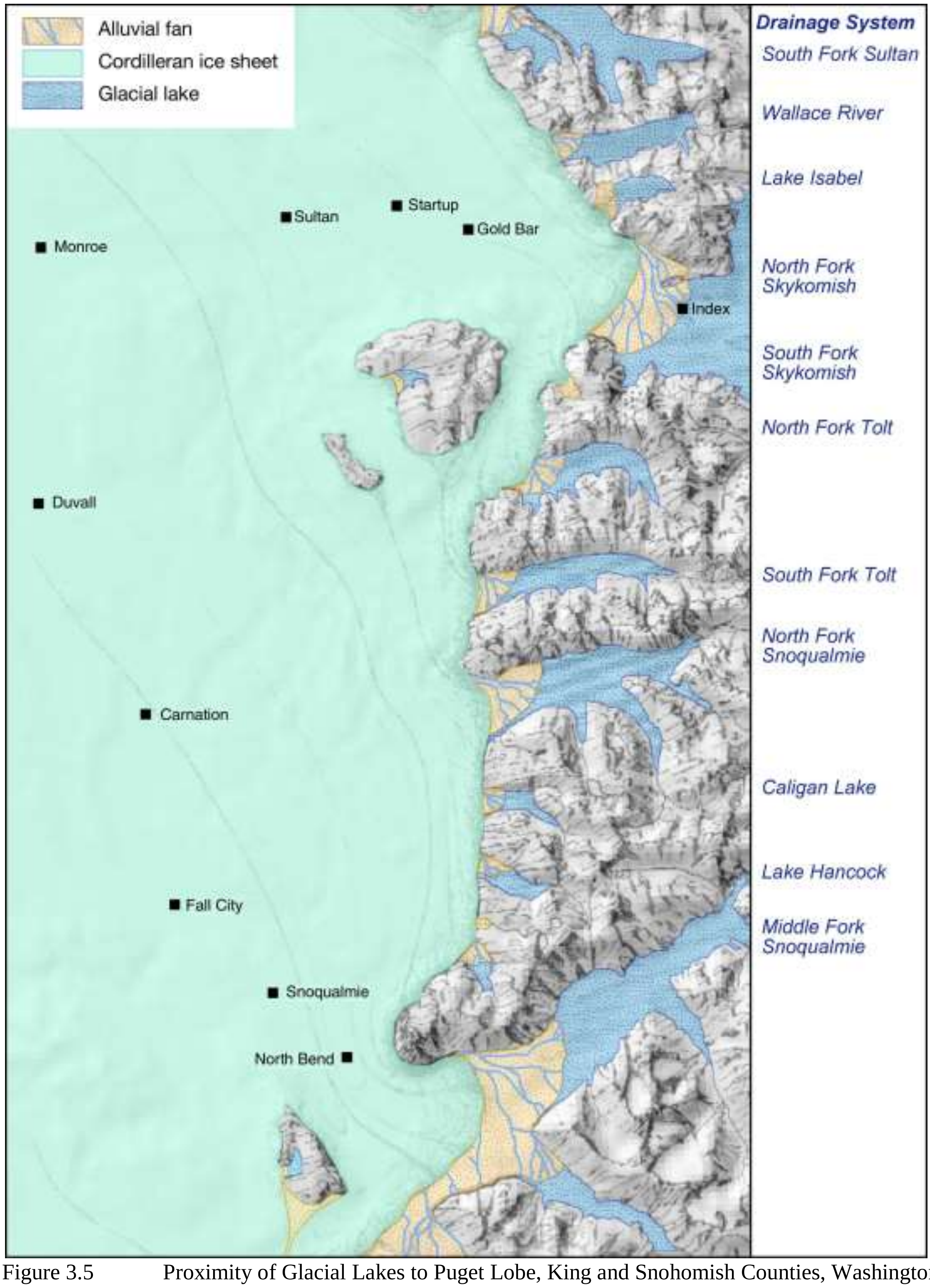


Figure 3.5 Proximity of Glacial Lakes to Puget Lobe, King and Snohomish Counties, Washington State (after Bretz 1923).

et al. 1958, Easterbrook 1969, 1986). The alpine glaciers in the Canadian mountains expanded and fed expansion of the Cordilleran ice sheet. The alpine glaciers in the Washington State mountain ranges began to recede and deposit their suspended drift by the time the Cordilleran ice sheet began to advance into the Puget lowlands. Some sediment from the receding alpine glaciers was deposited within the Puget Lowland but most remained around the base of the ranges (Crandell et al. 1958).

The Vashon Stade, the second of the Fraser glaciation, began as the Cordilleran ice sheet advanced to the south from the Fraser River Valley at 21 KBP and split into two separate lobes as it met with the Olympic Mountain Range. The San Juan Lobe formed to the west, through the Strait of Juan de Fuca, terminating in tidewater approximately 100km west of the present Washington coast, reaching the maximum southwestward extension of the Cordilleran ice sheet (Booth 1994, Easterbrook 1986). The terrestrial Puget Lobe formed between the Olympic and Cascade mountain ranges, scouring the previous glacial sediments and depositing "Vashon Drift". The Vashon Drift sediment sequence includes two primary sand beds deposited by melt water from the advancing glacial lobe, overlain by Vashon Till as the glacier advanced, capped with recessional sands and gravels from the glacial retreat (Armstrong et al.1965, Booth 1994, Booth et al. 2003, Easterbrook 1969, 1986).

The Everson Interstade followed the Vashon Stade. This was a period of glacial recession as the Puget Lobe retreated to the north. Several glacial lakes formed in place of the ice, eventually forming a single "Lake Bretz", which drained into the Chehalis River (Booth et al. 2003). As the glacier receded to the north of the Strait of Juan de Fuca, the lowlands became inundated with sea water where the landform had not rebounded from the isostatic depression left by the Puget Lobe. The result is a layer of glaciomarine/marine sediment reaching depths of 550 feet in certain locations (Armstrong et al. 1965). The Everson Interstade ended at roughly 12 KBP with a short resurgence of the Cordilleran ice sheet in northern Washington State (Booth et al. 2003, Porter and Swanson 1998). The final stade of the Fraser Glaciation is the Sumas Stade, ending around 10 KBP. The Sumas Stade is likely the Younger Dryas readvance of the Cordilleran into northern Washington (Kovanen and Easterbrook 2002; Easterbrook 1986).

East of the Cascade Range, continental glaciation during the Pleistocene further served to alter the Columbia Plateau landscape. The Cordilleran ice sheet entered the Columbia Plateau between approximately 20 to 18 KBP, scouring the landscape and blocking the Columbia River at several points along the northern margin of the Columbia Plateau. The Okanogan Lobe of the Cordilleran Ice Sheet filled the Columbia Valley and overflowed onto the north rim of the Waterville Plateau depositing giant erratic boulders and scouring the landscape. The Withrow Terminal Moraine, marks the southernmost extent of glacial advance into the Columbia Plateau (Easterbrook and Rahm 1970).

**Sea Level Rise and Isostacy**

The interaction of isostatic rebound with eustatic sea-level rise created a complex pattern of relative sea level change during the Pleistocene-Holocene transition. Along the outer coastal areas, sea-level was significantly lower than the present day. Barrie and Conway (2002) report the earliest record of late Pleistocene sea level position as 37 below sea level at 14.4 KBP. By 13 KBP sea levels dropped to their lowest point, roughly 150m lower than today, and maintained that position until at least 12.4 KBP (Barrie and Conway 1999; Fairbanks 1989, Josenhans et al. 1997). Eustatic sea level rise ensued in two marked pulses, separated by the Younger Dryas period, one between 13 and 14 KBP and later between 11.5 and11 KBP (calendar years; Fairbanks 1989). Following this, transgression occurred until 8.8 KBP when sea level stabilized roughly

15m above modern sea level, creating a raised marine terrace along the outer coast (Clague et al. 1982; Fedje and Christensen 1999).

On Camano and Whidbey Islands shorelines on the mainland coast were 50m above present-day sea level at 13 KBP. In southeast Alaska, evidence of raised sea levels is found along the Alexander Archipelago. Pleistocene sea levels in northern Puget Lowland (roughly north of Everett to the international border with Canada) were about 90 m above present levels. This is juxtaposed to the relative sea level change in the central and south Puget Lowland, Seattle-Olympia area, which was not as affected by isostasy. In this region sea level has risen steadily from about 40m below present levels, in relative concert with the rise in eustatic global levels (Thorson 1986, 1989, Sherrod et al. 2001).

At the last glacial maximum of the Puget Lobe (Vashon Stade), ice thickness at the US-Canadian border was as much as 1800m, and about 900m thick in the present Seattle area, terminating just south of Olympia (Easterbrook 1992). During the end of the Vashon Stade/beginning of the Everson Interstade, rising marine water inundated the Puget Lowland through the Strait of Juan de Fuca. At this point, roughly 13-14 KBP the Juan de Fuca lobe had ablated enough to allow the ocean water onto the mainland, behind the retreating Puget Lobe, increasing the rate of ice wasting (Thorson 1981, 1989). Proglacial lakes that had been draining south at the beginning of the retreat began to flow north; Glaciomarine and marine sediment accumulated over north western Washington as far south as Seattle and north into the Frasier Lowlands where the thick glacial ice had isostatically depressed the landform below sea level (Easterbrook 1992, Thorson 1981). With the absence of ice cover, isostatic rebound rapidly began to uplift the Puget Lowlands. Both isostatic uplift and depression in the Puget lowlands is relatively extreme compared to the expected rate of uplift for such events regionally and globally. Expected isostatic rebound rates are about 0-50% of total ice thickness at a given point- rebound rates for the Puget Lowlands, conservatively, range from 30-70% (Thorson 1981, 1989). After this time of maximum transgression, the relative sea level in strongly depressed areas rapidly fell to modern day positions by 9-8 KBP (Clague 1983; James et al. 2002).

Relative sea-level change in the northern Puget Lowlands follows the same general pattern as in the central portion of the lowlands, however, was subject to resubmergance and emergence following initial rebounding (Easterbrook 1963, 1992). Glacial loading during the Vashon Stade caused depression of the entire Puget Lowland. As the ice thinned, marine waters inundated the lowland, floated the remaining ice, and deposited marine sediments 13-14 KBP. Isostatic rebound occurred rapidly after deglaciation and emerged parts of the lowland before being overrun by globally rising eustatic sea levels 11-12 KBP (Easterbrook 1963, 1992 and Thorson 1981, 1989).

During the last glacial maximum it is possible that some areas were ice-free glacial “refugia” (Clague et al. 2004; Hebda, 1997; Heusser, 1989). Various proxy indicators of such refugia include endemic plants and animals, (Byun et al. 1997; Heusser, 1989) geological and paleontologic evidence (Barrie and Conway 2002a; Heaton and Grady 2003), fossil pollens (Hebda 1997) and glacial geomorphology (Mann 1986).

## Megafloods

At the close of the Pleistocene the Columbia Plateau experienced catastrophic deglacial flooding, scouring the ground surface to bedrock along its path, re-depositing sediment bodies in giant alluvial bedforms and features adjacent to the scour; soon after these floods occurred, Colonizers utilized the former flood pathways Figure 3.4). In terms of the Colonizer archaeological record this landscape relationship is key to understanding lifestyles of these early people (1) to provide a recognizable and datable baseline for site identification, and (2) to understand the status and chronology of pre-Clovis archaeological assemblages.

### History of Megaflood Research on the Columbia Plateau

It is not often that the process of scientific discovery is as interesting as the actual results and conclusions that are brought to light, but the history of megaflood research on the Columbia Plateau is compelling. When J. Harlan Bretz began his studies of the regional northwest geology in 1923 (his primary flood hypotheses were forwarded the same year in Bretz, 1923) he couldn't have imagined the magnitude of controversy that would follow. His descriptions of the scoured and denuded bedrock surfaces of the Columbia Plateau met with immediate controversy (Figure 3.6; cf. Allison, 1935; Flint, 1938; McKnight, 1927; Harding, 1929; Hodge, 1934). Descriptions of alluvial features in the barren desert of the Columbia Plateau, far from the primary waterway of the Columbia and Snake River drainages seemed counter to rational geological thought. Great V-shaped canyons and valleys termed "Coulees" with comparatively tiny streams coursing through their valley floor were conspicuous, enigmatic features that seemed foreign to the landscape. Placed within the historic context, Bretz' hypotheses were delivered during a period where descriptive science was seeking to lose the shackles of biblical catastrophism. Bretz' presentation of a prehistoric deluge, greater than any known to man ran counter to the gradualist notion that in order to understand our natural world, we should seek modern, systematic environmental correlates (see Gould, 1989 for a historic perspective).

Bretz spent a lifetime defending his interpretations against professional criticism and ultimately, shortly before his death at the age of 92, he was vindicated. Bretz was awarded the Penrose medal by the Geological Society of America for his lifelong achievement and determination. The unanimous acceptance of Bretz' hypotheses is characterized by a note sent to Bretz shortly after the 1965 International Association for Quaternary Research fieldtrip to catastrophic flood site locations on the Columbia Plateau (Bretz was unable to attend, but he recounts the story in Bretz, 1969). The note simply stated,

> 'Greetings and salutations, we are now all catastrophists'

In the four decades since Bretz' vindication that have passed, flood researchers have continued to fill in both theoretical and field-based gaps to more completely understand the details and breadth of the flood events. Although originally forwarded during the 1920s and refined through the 1960s, the primary hypotheses and supporting evidence for Bretz' work is accounted in his last cumulative argument for the floods (Bretz, 1969; Table 3.1).

Table 3.1 Primary hypotheses and supporting evidence for Bretz floods

1) Evidence for repeated catastrophic outbursts of glacially dammed Lake Missoula in Montana;
2) Consequent overwhelming, in many places, of the pre-glacial divide along the northern margin of the Plateau: Areas of relatively high topographic relief were overtopped, incised and stripped of surficial sedimentary geology
3) The re-channelization of the Plateau pre-glacial drainage pattern into an anastomosing complex of floodwater channels, defined as “Channeled Scabland” that is locally eroded in places into hundreds of feet of basalt bedrock;
4) Convergence of the many overland Plateau rivers into the Columbia River Valley, at least as far as Portland, Oregon;
5) Deposition of a huge catastrophic flood delta at Portland, Oregon.

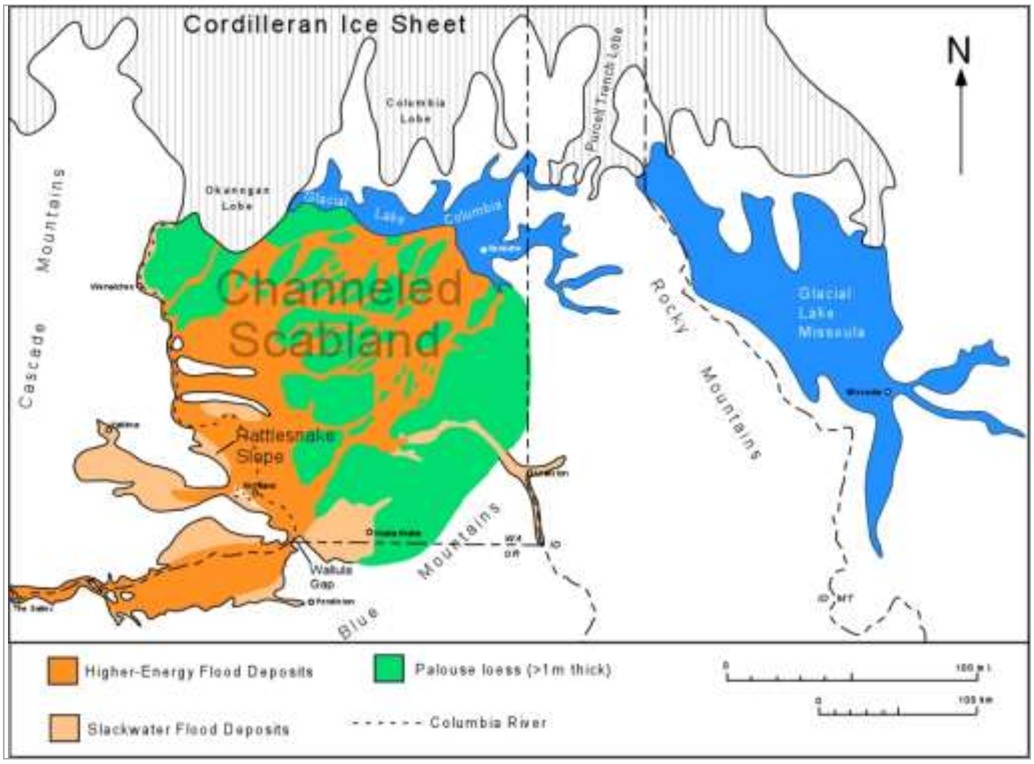


Figure 3.6 Location of the Missoula Floods in relationship to the Cordilleran Ice Sheet and the Columbia River system.

## The Relationship of the Scablands to Colonizer Archaeology

The Scabland of the Columbia Plateau is relevant to Colonizer archaeology due to the timing of its formation, the distinct sediment sequence located within, and because of the specific geomorphic features it created. Details of late-glacial megaflood deposits, including Scabland features which are ubiquitous to the interior portion of the Columbia Plateau are critical to locating and identifying colonizer period archaeology. Megaflood deposits and features, which generally include giant sand bars, megaripples, stacked lake sediments and adjacent scoured bedrock channels, act as regional archaeological “bedrock”, as they consist of clean, mineral sediments without potential to hold *in-situ*, buried archaeological material. Nonetheless, because of their upper Pleistocene origin, flood deposits are an excellent marker landform on which surface and near surface Pleistocene and early Holocene archaeology may be found. As a suite of geomorphic features, the overall scoured megaflood pathways, termed “scabland”, dominate the landscape. The local topographic variation created by the scabland contributes to ecologic and biotic differentiation—which together support resources that is critical to humans and their prey.

In Bretz’ second article which describes the unique physiographic features of the Plateau (1923b), again, written the same year he initiated research there, he introduced the geologic community with the term “Scabland” as follows: “The term Scabland and Scabrock are used in the Pacific Northwest to describe areas where denudation has removed or prevented the accumulation of a mantle of soil, and the underlying rock is exposed or covered largely with its own coarse, angular debris.” (Figure 3.7). To clearly describe his observations and to unambiguously define the Scabland topography, Bretz established a baseline for Scabland origin research and interpretation by describing features and relationships of the Scabland tracts. Bretz’ list is extensive; those elements with bearing on Colonizer archaeology are listed in Table 3.2.

Table 3.2 Features and Relationships of the Scabland Tracts (after Bretz, 1923)

1. Scabland tracts are developed invariably on or in the Columbia River Basalt formation.
2. Scabland tracts are invariably elongate and topographically lower than the immediately adjacent soil-covered areas.
3. Scabland tracts are invariably bound by maturely eroded topography.
4. Scabland tracts are connected with each other.
5. Scabland tracts with steep gradient are narrow, while those with gentle gradient are wide.
6. The pattern of scabland tracts, where hills of the older topography are isolated in them, is anastomosing or braided.
7. Scabland tracts invariably contain "channels." These are gorges, canyons or elongated basins eroded in the basalt.
8. Scabland tracts are invariably without a mantle of residual soil.
9. Scabland tracts are traceable up-gradient to a narrow basalt plain bordering the south side of the Spokane River in the northern parts of the Plateau. This basalt plain bears many glaciated errratic bowlders (sic) and some patches of till, but no channeled Scabland, no mature topography, no loessal soil.
10. There are but ten openings to this basalt plain to the north.
11. Scabland tracts are invariably traceable down-gradient to Snake River on the south or Columbia River to the West. There are nine places where scabland tracts enter these two streams.
12. There is no channeled scabland on the Plateau in western Idaho or south of the Snake River or west of the Columbia River.

**Source of the Floods: Glacial and Localized Ice Dams**

Early researchers recognized key flood features long before Bretz forwarded his broad Plateau-wide flood hypothesis. Early in the flood debates, Harding (1929) forwarded an alternative hypothesis to Bretz' catastrophic explanation for an unusually large water source (at the time even Bretz was troubled by the large volume of water necessary to support his hypothesis) that suggested localized ice dams throughout the Plateau might explain the formation of scabland topography. Pardee (1910) noted that T. C. Chamberlin recognized terraces along the former margin of Glacial Lake Missoula, suggesting that they may relate to a glacial dam (Figure 3.8). Ultimately, the hypothesis that large-scale ice dams clogged bedrock constrictions was derived and the glacial lake hypothesis was seen as the simplest, and therefore the best fit model.

Figure 3.7 "Typical Scabland setting at Drumheller Channels, central Washington State. Note outcrops of Columbia River Basalt bedrock forming topographic highs; recharge by the Columbia Basin Irrigation Project fills the scoured topographic lows with water.

Glacial lake Missoula, together with sub-glacial lakes, has affected topography of the Quaternary Columbia Plateau greater than any other force (Clark et al. 1984). Other glacial lakes (i.e., Lake Columbia and Lake Brewster) existed during this time period; however, the impacts of Lake Missoula floods are better documented and in places may mask those of the smaller, local lakes. Lake Missoula, created when a lobe of the

Figure 3.8 Terrace steps behind Missoula, Montana. Photo courtesy of Don Hyndman

Cordilleran ice sheet dammed the mouth of the Clark Fork River in North Idaho, existed for a 2,000 to 3,000-year period approximately 15.5 to 12.7 KBP (Fryxell 1962; Waitt and Atwater 1989) and emptied repeatedly as the ice sheet advanced and retreated. Before the formation of glacial Lake Columbia, floodwater from Lake Missoula would have flowed unencumbered through the Columbia River valley (Atwater 1984). Lake Columbia was created when the ice sheet blocked the ColumbiaRiver, forming a temporary glacial lake (Figure 3.9, Waitt 1987) before "overflowing Lake Columbia outlets and spreading across the Channeled Scabland" (Gough 1995). It has been proposed that Lake Columbia outlasted Lake Missoula by 200 to 400 years and may have been responsible for downstream terrace formation in the early Holocene (See pre-A1 braidplain deposition discussion below; Atwater 1984; Waitt and Atwater 1989).

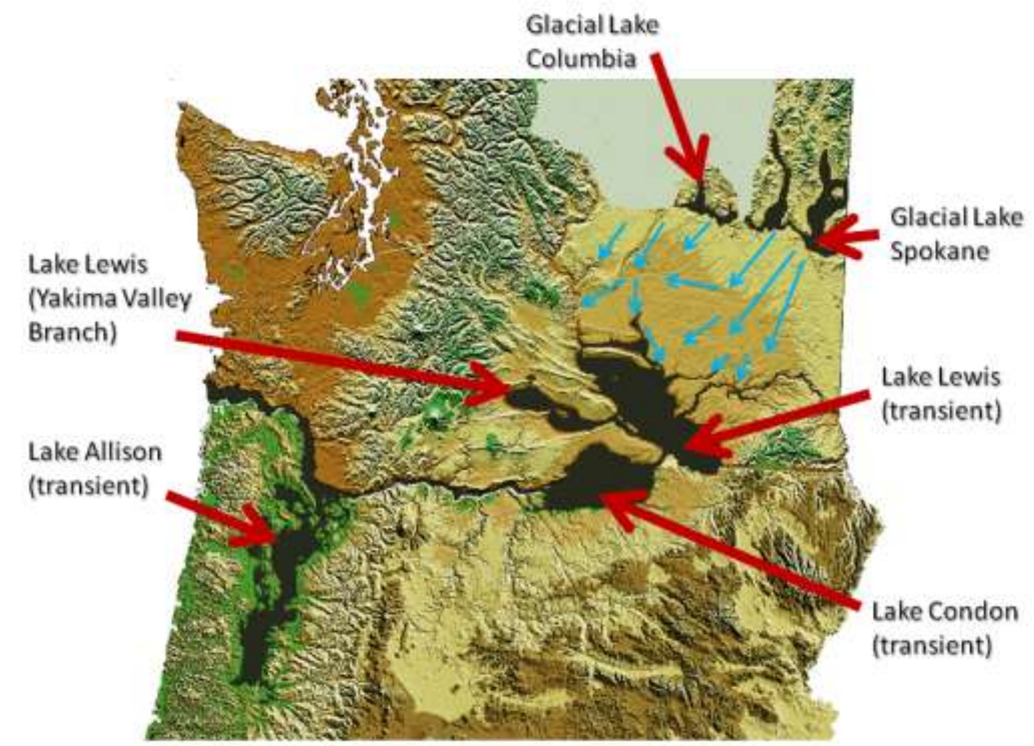


Figure 3.9 Location of Glacial Lakes formed by outflow of Glacial Lake Missoula

Lake Missoula's maximum volume is calculated at 2,184 $km^3$ (Clarke et al. 1984). When ice dams would break, floodwaters swept across the north central Columbia Plateau, scouring much of central Washington State and depositing beds of sand and silt, as well as frozen aggregates of gravel, and boulders along its course. A primary outlet for Lake Missoula floodwater was the Moses Coulee (Figure 3.10; Grolier and Bingham 1978).

Ice dams, such as the one that created Glacial Lake Missoula, are brought about by ice-rich water flowing through natural bedrock constrictions which occur at wind and water gaps through anticlinal landforms. These constrictions would essentially bottleneck the

Figure 3.10 Diversion of the Columbia River by the Okanogan lobe of the Cordilleran glacier was diverted through the Moses Coulee, now a dry canyon with an underfit, perennial stream on the canyon bottom.

flowing water become choked with ice and debris, and cause localized pooling. Evidence for such phenomena demonstrates that floodwater backed up into the Pasco,Quincy, Umatilla and Yakima Basins (Figure 3.9). Below the Rock Island Dam, megaflood deposits flowing through Moses Coulee may have temporarily blocked the Columbia River (Gresens 1983). At Sentinel Gap near Vantage, former strand lines are present both on the upstream side of the anticline, formed during damming of Sentinel Gap, and the downstream side at roughly the same elevation (~1000 feet), formed by backwater flooding of the Wallula Gap (Figure 3.11).

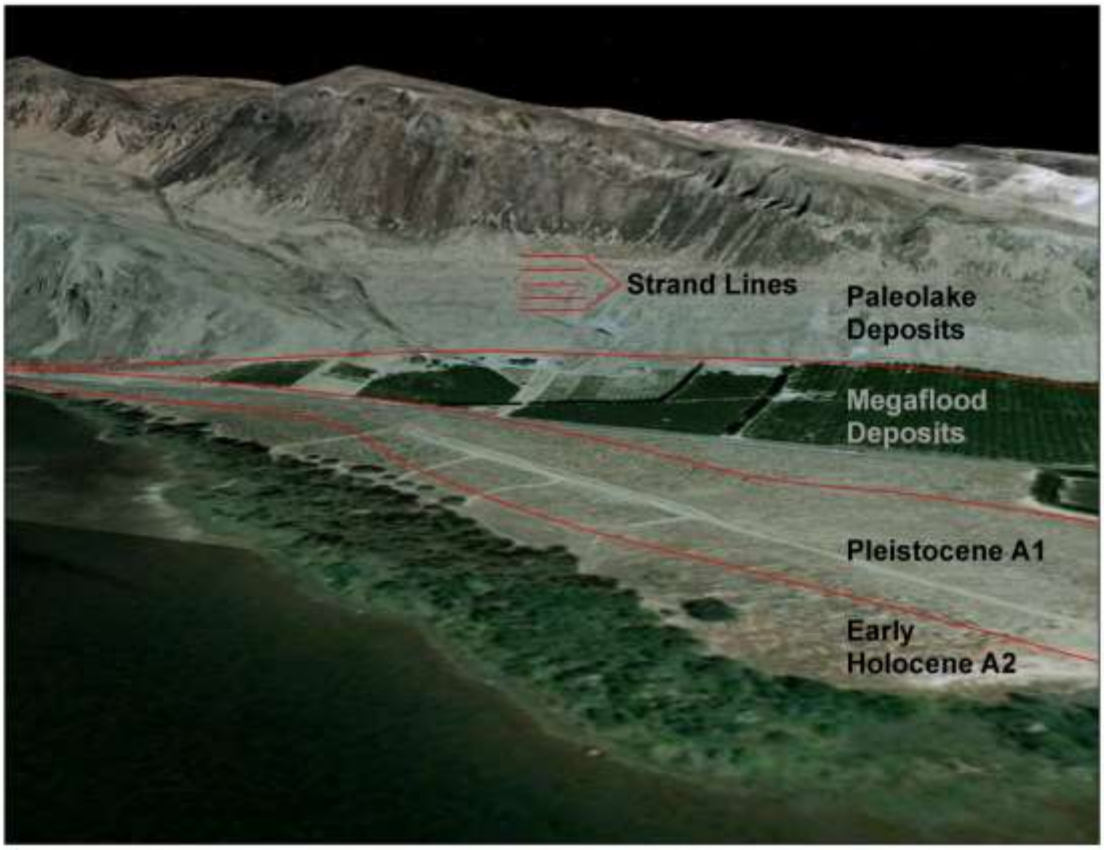


Figure 3.11 Strand lines exposed at Sentinel Gap, Columbia River, Washington State. Note upper Pleistocene to early Holocene terrace steps.

**Number and Timing of Flood Events**

A significant emergent controversy in the history of Bretz flood studies relates to the number of megafloods on the Columbia Plateau. In most places, sedimentary details are often ambiguous, leading to a classic case of convergence. Two broad hypotheses exist, 1) A single flood at the end of the Wisconsin period accounts for all of the stacked flood-related sedimentary deposition (Bjornstad 1980); 2) Multiple floods, possibly as many as several dozen, are represented by the stacked sedimentary deposits (Waitt 1980).

Bretz (1929) originally postulated that deep deposits of bedded flood sediments might relate to dozens of flood surges within a single catastrophic flood. In a later publication Bretz (1969) reinterpreted the fine-grained sequences, suggesting that although it was unlikely that each individual fine-grained bed represented an individual flood event, the cumulative stack of beds was too thick to be accounted for by a single flood. Despite the hesitation of Bretz, Baker (1973) and Bjornstad (1980) interpreted the thick accumulations of sediment as the result of isochronal flood surges. Sediments were hypothesized to be deposited during a period of attenuated flooding characterized by surges that emplaced sandy sediment at highest flood stage, dropping finer-grained suspended sediment load during periods of waning stage.

In a short series of papers, Waitt (1980; 1984; 1985) laid the groundwork for years of controversy (continuing through today) regarding the origin of Scabland flooding. Originally a proponent of the single-flood hypothesis (See Waitt, 1977), through extensive further research he postulated that as many as forty individual floods derived from Glacial Lake Missoula, each separated by a lengthy depositional hiatus, are represented by slackwater sediments (defined below) along the margins and up the valleys (backflooding) of the flood-scoured distal portion of the Plateau.

The evidence from which Waitt based his interpretation of slackwater backflooding includes:

1) Up-valley thinning and fining of locally-derived sediment bedload
2) Upvalley paleocurrent indicators, and
3) Upvalley transport of Cordilleran-derived erratics.

Evidence for a lengthy depositional hiatus between floods is interpreted from

1) Loess and slopewash-derived sediment capping rhythmic beds;
2) Presence of an airfall (*in situ*) Mt. St. Helens "Set S" (~12.8 KBP) tephra couplet (in places also a triplet) buried by subsequent flood sediments;
3) Filled rodent burrows, buried by subsequent flooding; and
4) dispersed Mammal skeletons.

Atwater (1984) interpreted slackwater sediments similarly in the northern portion of the Columbia Plateau. By counting varves between large flood beds, he calculated an average backflooding recurrence interval of 35-55 years. Atwater assumed that the source of water for the recurring floods was glacial Lake Missoula. Shaw et al. (1999) revitalized the case for a giant single flood. By calculating the volume of water necessary to scour and erode the entirety of the Scabland landscape on the Plateau, Shaw et al. suggested that sources of water in addition to Lake Missoula were not only likely, they were necessary to create the conditions required to emplace the megaflood sediment bodies. In addition, these authors suggest that previous researchers (Waitt, 1980; 1984; 1985; Atwater, 1987; Clarke et al., 1984) have misinterpreted sedimentary deposits across the Plateau, that a single, large flood fed by water from Cordilleran trunk valleys forming a gigantic subglacial reservoir is responsible for Scabland features and deposits. These more recent interpretations are supported by independent research of Komatsu et al. (1999) who corroborate Shaw's work by adding that as much as three times the amount of water known to have existed in Lake Missoula would be necessary to cover the flooded areas of the Scablands.

**Timing of the Floods**

The primary chronometric tools flood researchers have relied on include tephrochronology, radiocarbon dating, and on pre-Brunhes-Matuyama reversal flood bodies, paleomagnetism. Of these techniques, the one that is by far the most useful is tephrochronology. Volcanoes of the Cascade Range have contributed enormously to understanding relative Quaternary stratigraphic sequences on the Plateau.

Early research into flood timing included Fryxell (1962) who suggested a limiting age for the most recent flood event (32.7 KBP) based on wood and peat that were incorporated into the megaflood flow and deposited near the Wanapum Dam on the Columbia River. Fryxell determined that because the wood was likely a reworked bog the date was not likely representative of the flood itself. Other researchers estimated dates hovering around the terminus of the Pinedale [sic] glaciation (~20 KBP) as a limiting age for the most recent floods (Bretz, 1969; Baker, 1973). Bretz et al. (1956), Baker (1973) and Waitt et al, (1986) each suggested that upper-most Pleistocene glacial floods may also have occurred. Mullineaux et al, (1978) provided a tight correlation of Mt. St. Helens Set S tephra (~13 KBP) with terminal flooding across the Plateau, Waitt (1987) and Gough (1995) describe even later floods (Post Glacier Peak tephra), but these late floods were restricted to the Columbia River Valley.

**Slackwater Sediments**

Slackwater (back-flood) deposits include relatively fine-grained sediments (few cobbles with no boulders) and may display climbing ripples, massive and rhythmic bedding, and reverse grading. Bunker (1982) described the fine-grained facies of megaflood deposits as turbidite-like beds "characterized by Bouma B, C and D divisions". Such deposits are distinguished by alternating flow regimes. Generally, upper flow regime accompanies the initial flood surge followed by lower flow regime as water depth increases succeeded by a final return to upper flow regime with retreat of the water surge (Bouma, 1962).

In 1969 Bretz provided a broad description of episodes of backwater flooding that included observed and predicted sediment types associated with individual flood events. He noted that of all the geologic evidence for the floods, the slackwater deposits were the least understood, but those that were likely to add significant detail to the understanding of flood chronologies and discharge—based on their regular, rhythmic nature. Even so, the fine-grained deposits remained relatively understudied until the 1980s. Studies that address the fine-grained deposits in a general sense include Waitt (1980) and Bunker (1982). Detailed studies regarding the dynamic nature of and controls on sediment deposition include Baker (1973) and Waitt (1985).

In 1993, Gary Smith reported the results of his physical sedimentological study in which he attempted to resolve the origin of the slackwater deposits, the number of rhythmites deposited during each flood event, and the relationship of the rhythmite-depositing floods to scabland erosional and depositional features. Smith's work partially confirmed the multiple-flood-per-bed hypothesis of Waitt and others, but it also lent support to the hypothesis that large floods may grow vertically by flood surging. Smith showed that true long-term hiatuses in deposition are recorded *in some places*, but there are stratigraphic locations that record multiple-bed flood sequences (Smith, 1993).

**Periodicity of slackwater deposition: The sloth and the mountain sheep**

<u>Sloth</u>

Bretz (1959, 1969) described evidence for two separate flood events on the Babcock-Evergreen Ridge in western Grant County, along the western-most portion of the Scabland. The remains of a ground sloth have recently been recovered there suspended in upper-Pleistocene loess, radiocarbon dating indicates that the animal died 12,100±60 years before present (Hackenberger et al., 2004; Table 4.1). I completed a stratigraphic analysis of the Bishop Sloth site that I eventually incorporated into the Bishop Geosol "type transect" (Chapter 4). Stratigraphy of the site includes a megaflood slackwater base with an eolian sediment cap. The Badger Mountain and Bishop Geosols are present in the sediment stack, as are several upper Pleistocene tephras (Figure 3.12).

The sediment stack at the sloth locale consists of a series of glacial megaflood rhythmites (Baker 1973; Waitt 1985). Rhythmically bedded sediments are deposited by the waxing and waning flow of the megafloods. The coarse basal member is deposited during the initial flood surge, its finer-grained counterpart is deposited as the flood withdraws, dropping its suspended load. With successive floods, considerable stacks of sediment are built; thirteen flood rhythmite sequences are recorded at the Bishop Sloth locale. However, unlike most documented flood rhythmites, the Bishop Ranch Sloth Site facies Sm and Fm beds are massive, lack primary sedimentary structures and the range of grain sizes is not as great.

**Mountain Sheep: Background of discovery and stratigraphic situation**
While logging megaflood deposits in cutbank exposures near the Wanapum Dam in the central Columbia Plateau, I found the partial, articulated skeleton of an Artiodactyla between two Mt. St. Helens "Set S" ashes. The fossil was identified during a routine survey of small tributary drainages into the Columbia River Valley. The focus of the survey was to obtain stratigraphic information on megaflood deposits; the fossil was found within the upper megaflood section of an eroded stack of flood sediments. While it is not uncommon to find *disarticulated* faunal remains in megaflood deposits, *articulated* remains, which must reflect deposition of an intact carcass, are rare. Because the animal died at the time of the flood, radiocarbon dating of the remains will reflect not only the age of the animal, but the age of the flood as well.

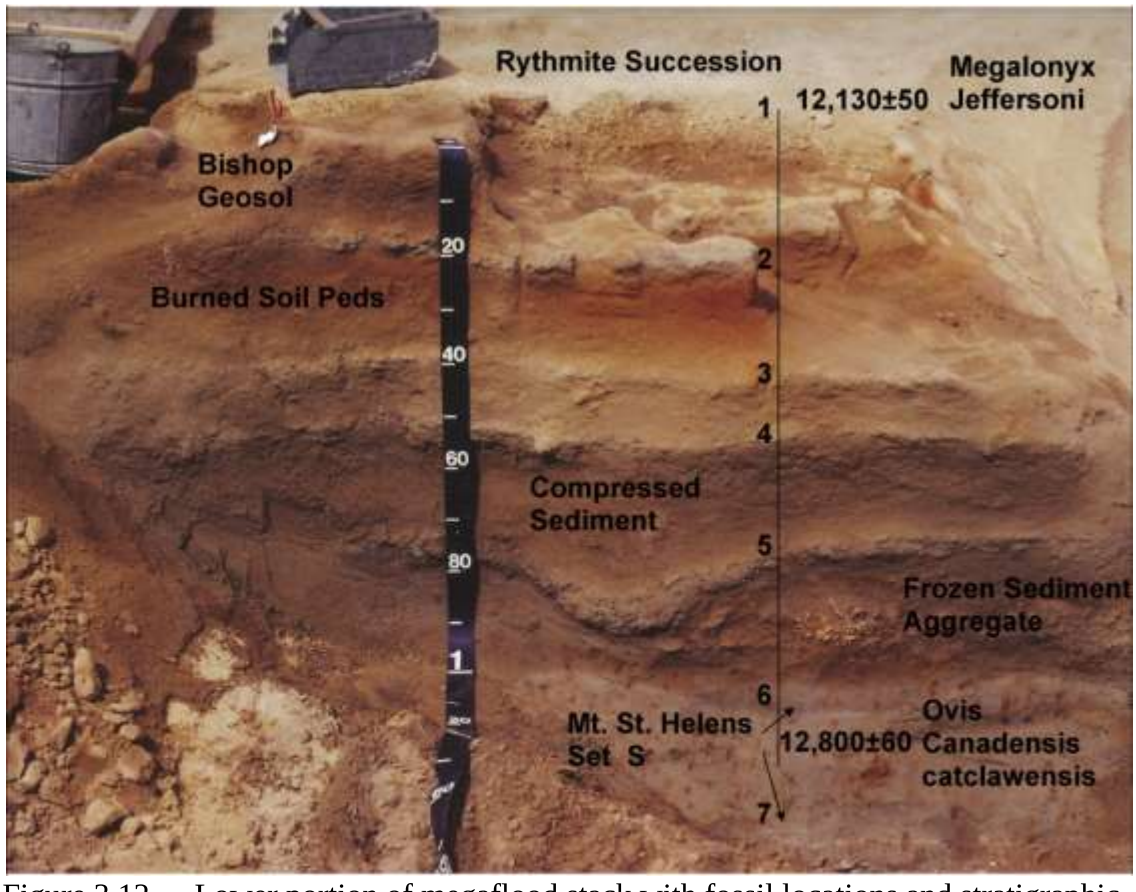


Figure 3.12 Lower portion of megaflood stack with fossil locations and stratigraphic interpretation. Peds=soil aggregates.

## Stratigraphy of the Sheep Locale and Fossil Recovery

The megaflood sediment that held the Ovis fossil was a stack of megaflood deposits overlain by Holocene eolian sediment. Within the flood beds were two clear tephra horizons of Mt. St. Helens Set S ejecta. At the time I discovered the fossil, the site was eroding rapidly due to agricultural runoff; within a 24 hour period the entire sediment stack at the fossil site was eroded away. Exposure trench 18 (Appendix 1) displays the stratigraphic situation of the fossil locale. Trench 18 is located on the same tributary reach, within 50 meters of the fossil and its stratigraphic setting is identical to the fossil location. As a result, I was able to correlate the depositional beds of tephra directly from the fossil to the trench location, and extrapolate the age of the fossil to the intact sediments in trench 18.

On discovery, the articulated vertebrae section of the fossil was partially exposed on a short bench over the flowing water below and there were several skeletal elements lying on the lag sand. The relationship of the in situ portion of the fossil to the tephras was very clear, but the context of any other elements that had already eroded was disturbed. Three megaflood units were clearly present overlying the upper of the two tephras, but there was a smooth unconformity between the cap of the megaflood stack and the overlying eolian sediment, indicating erosion of one or more upper beds, so it was not possible to determine the total number of flood beds deposited at the site. The base of the flood stack was deformed, displaying ball-and-pillow structures, suggesting rapid deposition and differential densities of the flood beds.

The partial fossil was exposed in the cutbank, although clearly articulated (see vertebral section Figure 3.14). As the spring meltwater was high and moving rapidly, recovery of the skeleton was difficult. Although it was possible to recognize the relationship of the fossil to the stratigraphic sequence, in particular, the tephra couplet, the rate of erosion of the bank was such that the fossil would be lost if not recovered immediately. Using a trowel and brush, I removed all exposed bone, taking care to keep the vertebral column intact as a means of demonstrating articulation and therefore a direct correlation of the fossil age to the timing of the flood (Figure 3.14). The remaining bones were excavated by drawing the loose sediment away from the bank, into the flowing water.

Sediment at the fossil locale consisted of the full expression of the regional pedologic sequence; the Willow Lake, Badger Mountain and Bishop soils were clearly present. The basal sediment which held the fossil consisted of relatively coarse (fine sandy loam) slackwater sediments with Bishop geosol formed into the cap of the deposit. This was overlain by an eolian section with both Willow Lake and Badger Mountain soils.

### Identification of fossil species

Timothy Held (Western Michigan University) identified the fossil as belonging to a species in the sheep genus, *Ovis*[2]. Paleontologists interested in North American mountain sheep evolution have designated sheep specimens more than 10 KBP into the genus and species *Ovis catclawensis* (Hibbard and Wright, 1956). Although some authors now regard *catclawensis* as a temporal subspecies of *O. canadensis* (Harris and

[2] A detailed description of the sheep is in preparation (Lenz and Held in prep.), but a preliminary analysis is provided here.

Mundel, 1974; Kurten and Anderson, 1980), others believe it is distinct (Martin and Gilbert, 1978). In order to make a species determination the Wanapum megaflood fossil was compared to anatomically modern mountain sheep (*O. candensis*); time constraints have prohibited a direct comparison to the species catclawensis. Even so, given the age and robusticity of the specimen, it is considered to most closely resemble *Ovis canadensis catclawensis* and it is likely that it would be placed into the *catclawensis* species by the proponents of the extinct taxonomic group.

The skeletal elements used to classify the animal include teeth, mandible, atlas and axis. Due to the level of confidence in the accuracy of the identification using these elements together with time constraints, little attention was given to the ox coxae. As of the time of this writing these are the oldest mountain sheep bones known from Washington State.

**Wanapum fossil details**

The Wanapum megaflood fossil is not complete: it includes the right mandible, both os coxae, the atlas and axis vertebrae and eight more vertebrae; four of which are likely cervical and four likely thoracic (Figure 3.13). There are two aggregations of megaflood matrix which contain articulated vertebrae, likely seven thoracic vertebrae in total (judging by the morphology of the spinous processes on the dorsal side of the vertebrae, Figure 3.14). Twelve unidentifiable fragments appear to be small pieces of vertebrae.

Figure 3.13 Megaflood Fossil

Figure 3.14 Articulated vertebrae in matrix

**Sheep Mandible**

A very large muscle attachment originates on the horizontal ramus of the mandible just posterior of the angle Figure 3.15B). A very pronounced line originates on the dorsal side of the attachment and runs up the ascending ramus at the same angle of the ramus (Figure 3.15A). The line terminates at the point where the ascending ramus diverges into the coronoid process and the mandibular condyle. Nearly identical muscle attachments and lines were found on comparative mandibles of modern Mountain Sheep at Washington State University, Pullman, WA, the key difference being robusticity of the megaflood fossil. The vertical thickness of the horizontal ramus of the mandibular body was similar to the comparative collections (Figure 3.15C), but like the other features, the megaflood fossil was more robust.

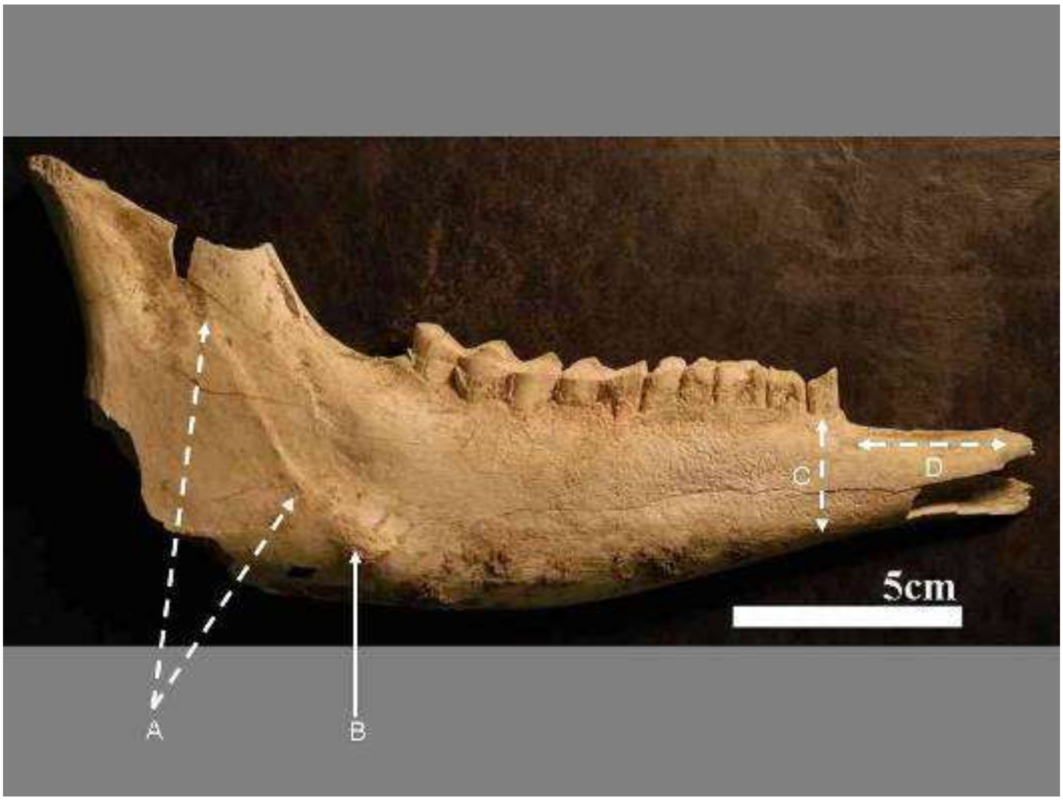


Figure 3.15 Lateral view of the right mandible. A.) Line running up ascending ramus B.) Muscle Attachment C.) Tapering of mandibular body below premolar 2 D.) Diastema

**Teeth**

Alveolar and individual tooth measurements (premolar 2-molar 3; hereinafter referenced as P and M) were compared to similar measurements from Stokes and Condie (1961), Harris and Mundel (1974) and other studies of *Ovis* (

Table 3.3). These measurements included two different *Ovis canadensis* fossils as well as the measurements from Hibbard and Wright's *Ovis catclawensis* (1956). In some ways the megaflood specimen is more similar to Hibbard and Wright's *catclawensis*, such as in the molar 1-3 width, however in the premolars it is closer to modern *canadensis*.

| Table 3.3 | Comparison of dental measurements from the Grant County Specimen and 3 specimens of *O. Canadensis* and 1 *O. catclawensis*. All measurements are in mm. |
|---|---|

W = width, L = Length, X = no measurement available

| **Fossil** | **Alv** | **p2 W** | **p2 L** | **p3 W** | **p3 L** | **p4 W** | **p4 L** | **m1 W** | **m1 L** | **m2 W** | **m2 L** | **m3 W** | **m3 L** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (This Study) | 90 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 13 | 12 | 17 | 12 | 31 |
| *O. catclawen* (Hibbard Wright) | 101 | X | X | 8.5 | X | 9.8 | X | 11 | X | 12.5 | X | 128 | X |
| *O.Canade* (U of Utah) | 86 | 5.5 | 6 | 7 | 9 | 8 | 10.5 | 9.5 | 14 | 11 | 18.5 | 10.5 | 28 |
| *O.Canade* (U of Utah) | 83 | 6 | X | X | 7 | 8 | X | 10 | 12.5 | 10 | 17 | X | 27 |
| *O. Canadensi* (Dry Cave # 22-250, NM) | X | X | X | X | X | 9.8 | 11.9 | 10.5 | 14.1 | X | 20.1 | X | 27 |

Occlusal wear on the fossil mandible teeth is extreme due to the combined effect of use wear and taphonomy. Nonetheless, the crown shape is preserved and a near match to those of the comparative collection sheep. The shape of the fossil m3 is significant. Most mammalian m3s are larger than the m1 and m2 because of a lobe on the distal side of the talonid. The m3 lobe on the megaflood fossil has buccal-lingual compression at the distal end of the talonid where the lobe originates (Figure 3.16). This lobe was also observed in the comparative specimen, although it was not as pronounced. The difference in size is likely explained by genetic variation within the species and evolutionary changes the mountain sheep has undergone in the 13,000 years since its death.

**Atlas and Axis**

The axis of the fossil was nearly identical to that of the comparative modern specimen. Once again, the only marked difference was the robusticity of the fossil. Interestingly the odontoid process of the axis is almost the same size in both specimens. Also, the

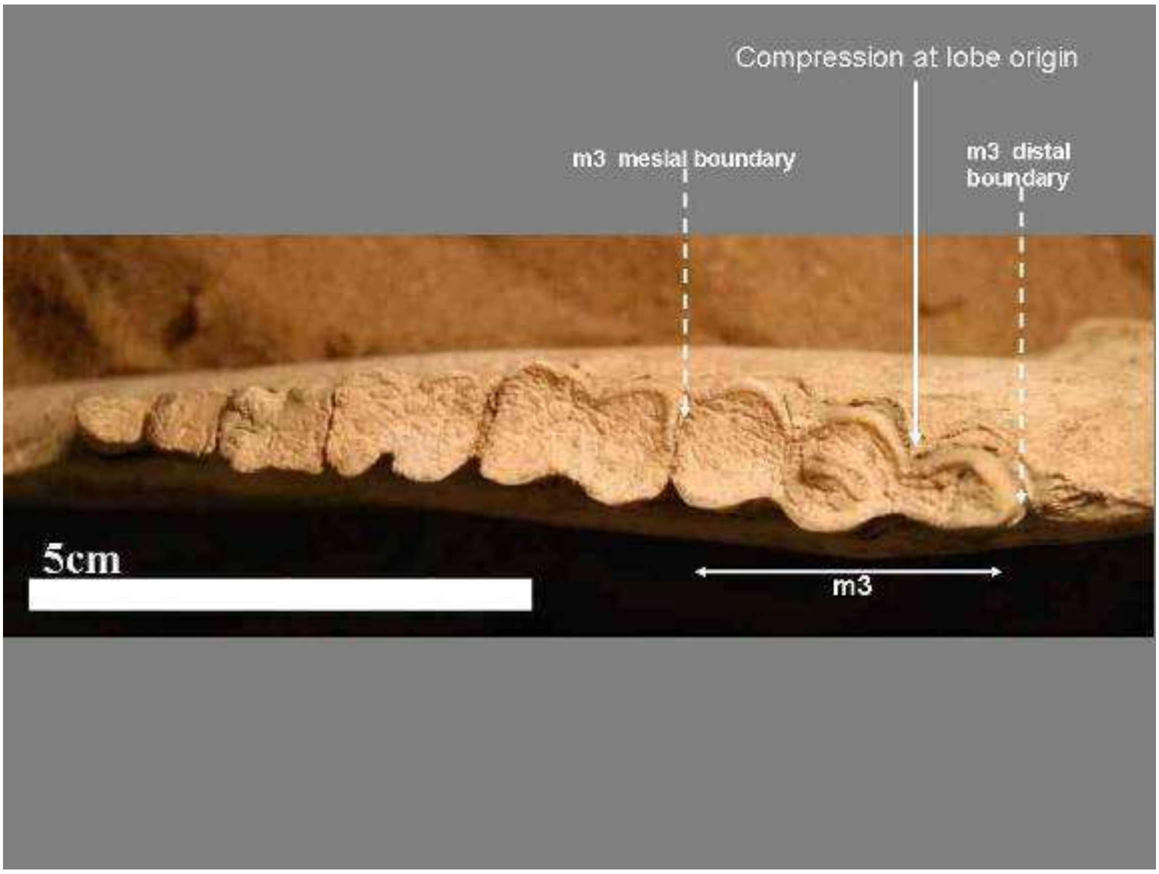


Figure 3.16 Occlusal view of premolar 2-molar 3.

photos of mountain sheep atlas and axis from Gilbert’s (1990) Mammalian Osteology are a very close match to the specimen, especially the axis (Figure 3.17).

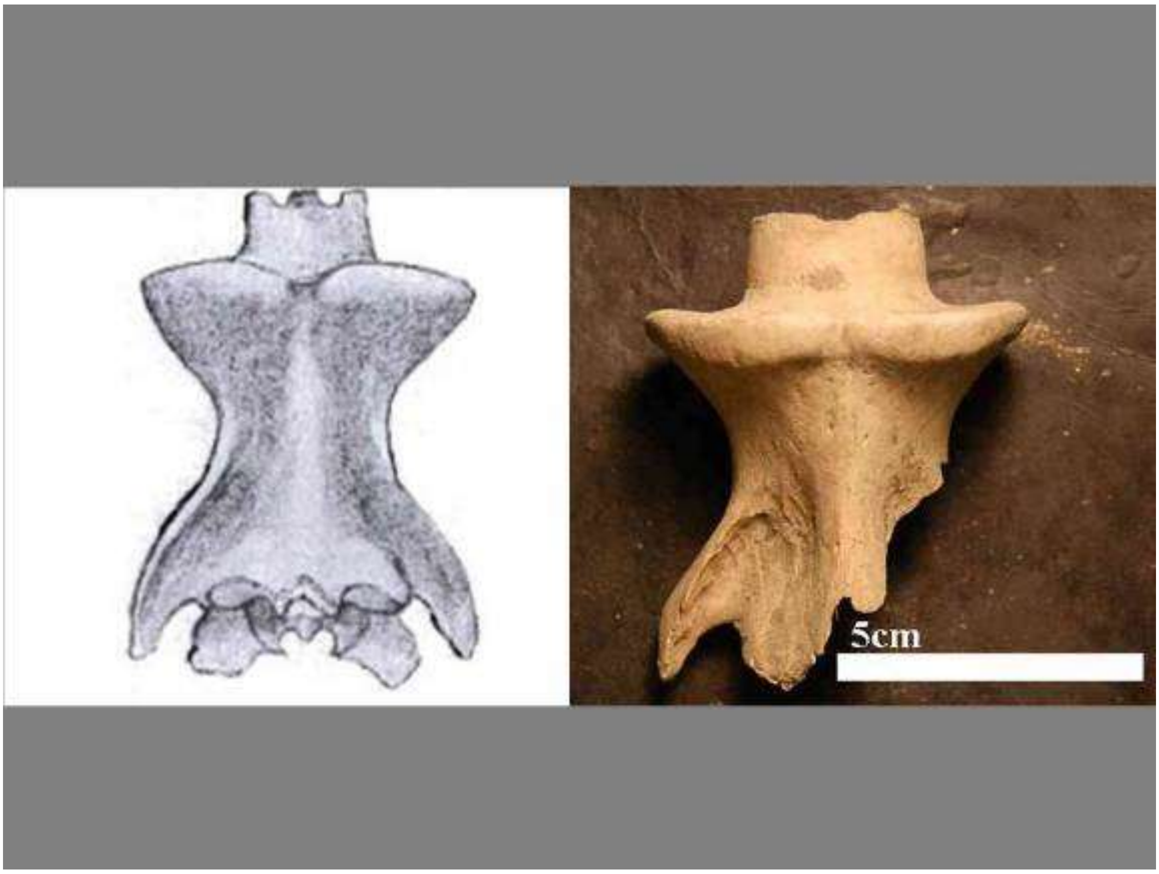


Figure 3.17 Side by side comparison of an illustration of an *Ovis canadensis* axis and the specimen's axis (Pen and ink llustration from Gilbert 1990)

**Radiocarbon age of St. Helens Set S tephra**

Radiocarbon ages have been obtained on fossil plant material associated with deposits of the St. Helens S eruptions (Table 1). None of these radiocarbon ages precisely date the eruption; they are bounding dates that represent minimum or maximum ages of the tephra eruption. Peat from above and below the St. Helens S tephra layer 50 km northeast of Mount St. Helens yielded AMS radiocarbon ages of 13.65 KBP (W-3136) and 12.12 KBP (W-3133) years BP. South of the volcano, a date of 12.91 KBP (W-3141) was obtained on charred wood (Mullineaux 1986: All dates presented in Table 3.6).

AMS radiocarbon dating of bone collagen from the fossil provides a direct numeric age of the flood (12,800±60; CAMS 59589: Table 4.1), but because the fossil was discovered between two tephra layers, it also provides an indirect (although very close) age of the Set S volcanic eruptions.

**Stratigraphic correlation between fossil sites and implications for flood timing**

Atwater (1984) described at least 15 Missoula flood events on the Sanpoil arm of glacial Lake Columbia. Based on the presence of varves between 14 of the flood beds he calculated a periodicity of floods, likely from Lake Missioula, every 35 to 55 years. This periodicity is consistent with that calculated from the correlation between the Bishop Sloth and Wanapum Sheep localities.

When considered in light of the sheep fossil date (12.8 KBP) the following scenario is likely regarding the timing of the final (uppermost Pleistocene) Scabland (non-mainstream-restricted Columbia River) flooding.

The sheep was killed by one of the final major scabland floods at 12.8 KBP. Mt. St. Helens erupted its Set S tephra shortly prior to and after the flood that killed the sheep. These same floods were the last to over-top the Babcock structural Bench at an elevation of ~900-940 feet, as evidenced by the giant longitudinal (pendant) flood bars present there. Adjacent to the large flood bars the landscape was stripped bare by the same floods, leaving a thin (< 10cm thick) lag sand behind in places. With each subsequent flood the high elevation Babcock Bench locale received a thin, coupled layer of flood sediment, two of which included Mt. St. Helens Set S tephra in their cap. The large bars were available as a ready sediment sources for upper-Pleistocene and earliest Holocene loess. Eolian deposition from the bars took place rapidly after their emplacement, burying the scoured bedrock surface. Between 12.8 KBP and the death of the sloth adjacent to a waterhole at 12.1 KBP, the last flooding occurred.

**Flood Stratigraphy and Geomorphology**

Back-flood and slackwater deposits include relatively fine-grained sediments (few cobbles with no boulders), the distal equivalent of the mainstream flood gravel. Fine-grained sediments deposited under these conditions may display climbing ripples, massive and rhythmic bedding, and reverse grading. Bunker (1982) described the fine-grained facies of megaflood deposits as turbidite-like beds "characterized by Bouma B, C and D divisions". Such deposits are distinguished by alternating flow regimes. Generally, upper flow regime accompanies the initial flood surge followed by lower flow regime as water depth increases succeeded by a final return to upper flow regime with retreat of the water surge (Bouma, 1962).

In 1969 Bretz provided a broad description of episodes of backwater flooding that included observed and predicted sediment types associated with individual flood events. He noted that of all the geologic evidence for the floods, the slackwater deposits were the least understood, but those that were likely to add significant detail to the understanding of flood chronologies and discharge—based on their regular, rhythmic nature. Even so, the fine-grained deposits remained relatively understudied until the 1980s. Studies that address the fine-grained deposits in a general sense include Waitt (1980) and Bunker (1982). Detailed studies regarding the dynamic nature of and controls on sediment deposition include Baker (1973) and Waitt (1985).

In 1993, Gary Smith reported the results of his physical sedimentological study in which he attempted to resolve the origin of the slackwater deposits, the number of rhythmites deposited during each flood event, and the relationship of the rhythmite-depositing floods to scabland erosional and depositional features. Smith's work partially confirmed the multiple-flood-per-bed hypothesis of Waitt and others, but it also lent support to the hypothesis that large floods may grow vertically by flood surging. Smith showed that true long-term hiatuses in deposition are recorded *in some places,* but there are stratigraphic locations that record multiple-bed flood sequences (Smith, 1993:97).

## Giant Current Ripples

Giant current ripples with height as much as 50 feet are not uncommon along the flood courses, throughout the scabland. Bretz (1969) reports that Pardee (1942) originally recognized giant current ripples that he associated with the outflow of Glacial Lake Missoula. Known giant ripple sites include West Bar, near Quincy, Washington, the outlet channel of Wilson Creek in the Upper Quincy Basin, Upper Crab Creek, along the Palouse River and in Palouse Canyon, at Drumheller Canyon south of Washtucna Coulee, and at the Chandler Narrows in the Yakima Basin.

## Flood Paths: The Coulees

Great V-shaped canyons and Valleys that are dry or those with grossly underfit streams present in their valley floor mark former flow channels of the catastrophic floods. Such features are termed “coulees”, perhaps the megaflood feature with highest correlation to Colonizer sites. Numerous pre-flood-hypothesis reports discuss the likelihood of a glacial Dam diverting the flow of the Pleistocene Columbia River through the Grand Coulee (as reported in McKnight 1927; Symons, 1882; Russell, 1893:91; Salisbury, 1901:721-24; Calkins, 1905:43-44; Oestreich, 1915; Schwennessen and Meinzer 1918:135).

Several Channeled Scabland coulees of the central Columbia Plateau include Moses Coulee, Lynch Coulee, Crater Coulee, Potholes Coulee, Frenchman Coulee and Crab Creek (Grolier and Bingham 1978). Small pothole lakes and springs are found in the bottom of these coulees, some of which carry intermittent and underfit streams. These water sources would have been extremely important resources for the Colonizer period inhabitants of the area. Evidence for human occupation prior to 12 KBP is likely restricted to elevations that were not inundated by late-Pleistocene flooding.

Coulees are important features because their valley floors contain Upper Pleistocene age sediments, and water that flowed for a good portion of the year. Such places are likely spots to find Colonizer archaeological sites -- the Lind Coulee site, and the Winchester Clovis site (Chapter 2) are excellent examples. While water flowed through the coulees at the close of the Pleistocene, in most cases, it ceased to flow as the climate gradually dried. Today, water is again present in many of the coulee bottoms: the Columbia River Irrigation Project has diverted water from the Columbia River into the dry uplands of the central Columbia Plateau. These waters have recharged former Pleistocene waterways both in coulee and seep areas throughout the Scabland (Tolan et al. 2009; Moody, 1978), making this the single most powerful tool in Colonizer archaeological site identification on the Columbia Plateau.

## Glacially-derived Loess

Loess sediment is the product of mechanical weathering (by erosion) from frost-pulverized outwash of glaciers and glacier-fed alluvium. In the central Columbia Plateau loess has been a ubiquitous feature of the landscape since at least the middle Pleistocene. Most recently, at the close of the Pleistocene, glacial outwash sediments dominated the Columbia River trench. Towards the north and east of the Columbia River, vast expanses of sand and silt have accumulated in the uplands by eolian redeposition of these floodplain sediments to form the Palouse loess formation (Busacca et al. 1992). Figure 3.18 displays the location of the Palouse loess in the

Pacific Northwest. At its deepest, the loess is 75m thick. It lies unconformably on Columbia River Basalts, a stratigraphic relationship that is known as a result of broad megaflood scour which has exposed deep cuts in the loess.

In terms of physical attributes, Russell (1897) was the first to discuss the Palouse loess. Early research on the loess was undertaken by Vlassoff and Wheeting (1937), who described its morphology and genesis. Kirkham et al. (1931) initially described the topography of the Palouse hills. Kaiser et al. (1951), critical of Kirkham et al. for restricting the description to a small subarea of the Palouse, expanded the description to the broad area of southeast Washington, western Idaho and northeast Oregon. Relief in the Palouse is around 200 feet while many ridges are oriented in a southeasterly to northwesterly direction with maximum steepness on the northern slopes. These are the loess “drumlins” described by Baker (1973), landscape features that are erosional rather than typical depositional glacial drumlins. Crescentic dune landforms with cirque-like

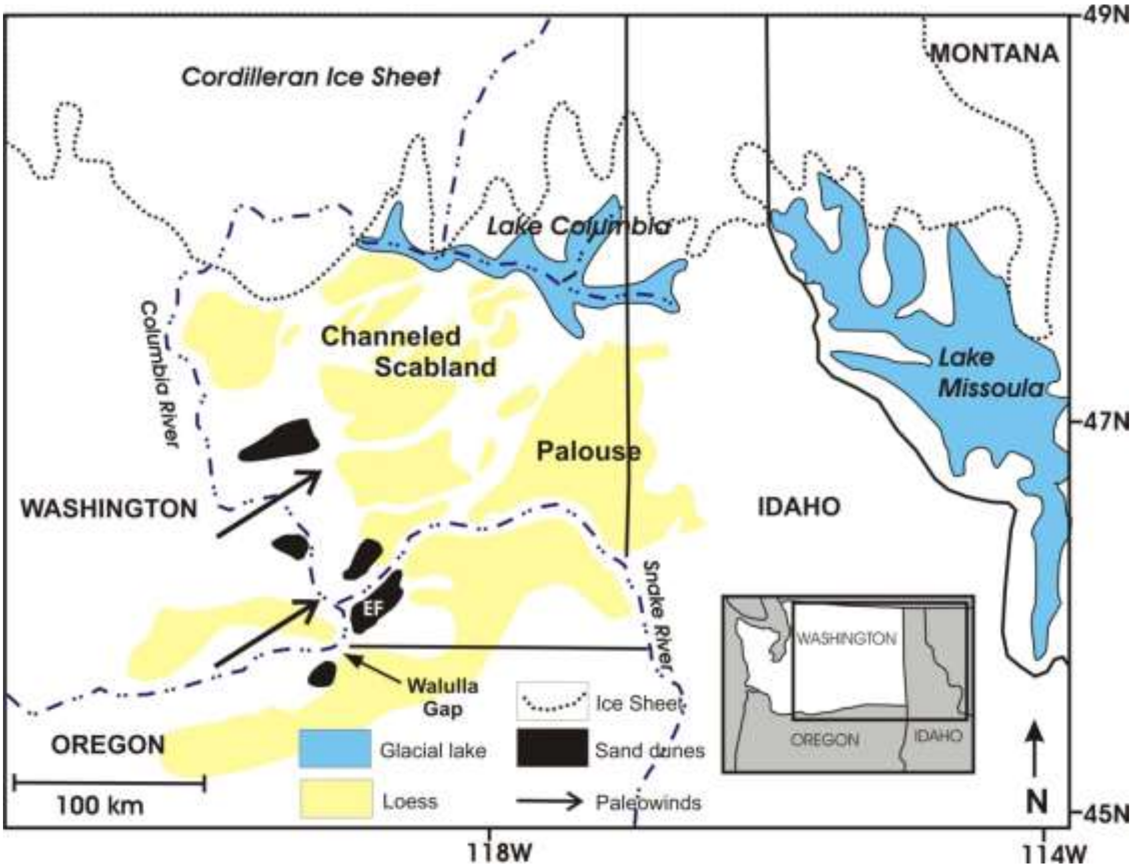


Figure 3.18 Location of Palouse Loess, glacial front and paleolakes at last glacial maximum, Pacific Northwest Region (Data courtesy of Mark Sweeney, University of South Dakota).

headward erosion profiles are common in sediment source-proximal areas. Overall, the Palouse loess parent material has created a gently undulating landscape that is in stark contrast to the eroded and denuded scabland that surrounds and bisects the broad loess plain.

Fryxell and Cook (1964) and Richmond et al. (1965) developed baseline information on loess generation and paleosol stratigraphy. Foley (1982) refined these chronologies based on a deep roadcut exposure of loess and was able to determine a pre-Brunhes-Matuyama reversal in the loess stack, verifying at least a middle Pleistocene age for initiation of Columbia Plateau loess generation. Since these studies, McDonald and Busacca (1991) and Busacca et al (1992) have continued to refine our understanding of the loess, adding significant detail to timing, genesis and paleosol formation.

Palouse loess stratigraphy is divided into informal chronostratigraphic units (Busacca and McDonald 1994), two of which span the period of time from the glacial maximum to the present: the L1 loess, which is defined as spanning the time period from the present to 15 KBP, and the L2 loess, which extends beyond the glacial maximum. For the purpose of describing and identifying Colonizer archaeology, I will focus on the L1 loess. Figure 3.19 presents a typical backhoe exposure of L1 loess with associated paleopedology.

The L1 loess contains the modern surface soil, the Willow lake Paleosol, both the Badger Mountain and Bishop geosols (Chapter 4), Mt. St. Helens Sets “S” and “J”, Glacier Peak, and Mazama tephras. Busacca and McDonald, (1994) and Sweeney et al. (2007) defined the base of the L1 loess in one of several ways, 1) by the Mt. St. Helens Set ‘S’ tephra. 2) where St. Helens Set “S” tephra is not present, the base of the Sand Hill Coulee Soil (the local, Palouse equivalent of the Bishop and Badger Mountain geosols of Chapter 4); 3) by the cap of the Washtucna Soil, a local, Palouse glacial maximum paleosol that marks the base of the L2 loess; and 4) the contact with megaflood sediments. Sweeney et al. (2007) describe the L2 loess as spanning the time period 15–70 KBP. Its base is defined by the contact with the Washtucna Soil (20-40 KBP), which

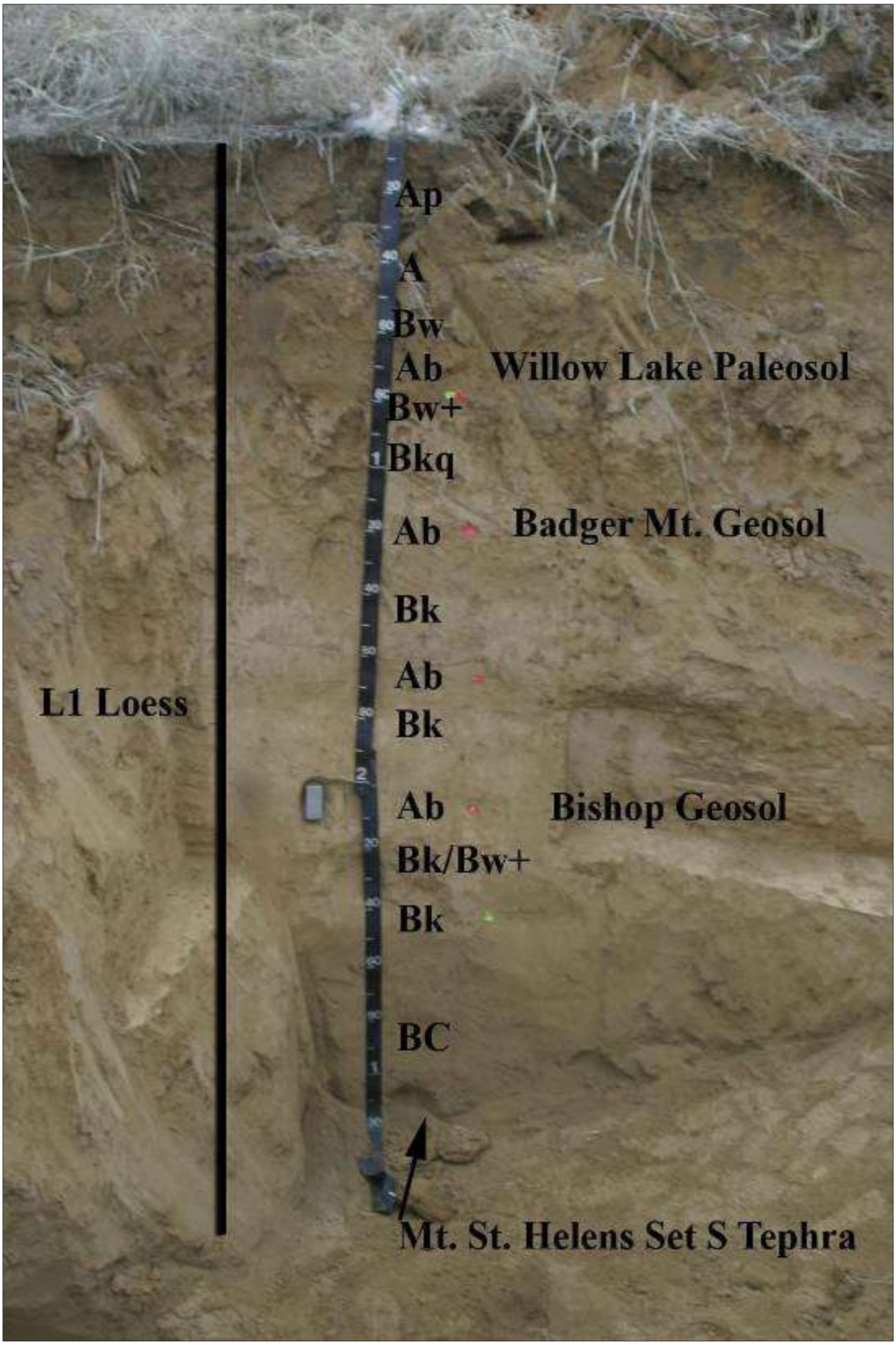


Figure 3.19 Field exposure of L1 loess (described above) with paleopedology

leaves a discrepancy in time of approximately 5 thousand years. For the purpose of this work, Colonizer archaeology may exist in L1 loess sediment that is post (overlying) Washtucna Paleosol and post-megaflood in age.

**Younger Dryas**

In order to understand the paleoenvironmental context of colonization, it is critical to review details of climate change that marked the close of the Pleistocene. A glacial re-advance termed the Younger Dryas, occurring between 11 and 10 KBP. (Clark and Lear 1992; Clark and Bartlein 1995), is characterized as the coldest of late to post-glacial cold periods that mark the Pleistocene to Holocene transition (Bradley 1999). Initial colonizers entered the region prior to the Younger Dryas, during the Bolling/Allerod period. Even so, the Younger Dryas signature in the stratigraphic record is important to recognize, if for no greater reason than to use it as a stratigraphic frame of reference. Environmental response to this cold period is suggested in the Interior Pacific Northwest through several lines of evidence.

The close of the Pleistocene period was marked by significant climatic fluctuation. Broecker et al. (1989) hypothesize that the cause for Younger Dryas cooling may relate to a sudden late-glacial shift in flow of Laurentide Ice-sheet runoff from the Mississippi drainage into the St. Lawrence River. This is suggested to have caused a freshwater dilution of ocean surface waters accompanied by a sudden decrease in the rate of North Atlantic Deep-Water production.

Periods of major climatic change at the end of the Pleistocene include a hypothesized prime mover, termed "Heinrich events" that are likely related to Younger Dryas cooling (Heinrich, 1988). Bradley, (1999) and Clark and Bartlein, (1995) explain that Heinrich events are recorded in the form of lithic detrital additions to marine sediment cores that are correlated across wide areas of the North Atlantic. The origins of the sediment additions are thought to be the result of massive discharges of icebergs into the Atlantic Ocean carrying Pre-Cambrian shield and other exotic detritus (Bradley, 1999). A hypothesized sequence of events during a Heinrich episode includes 1) growth of the Laurentide ice-sheet to a point of instability, 2) subsequent cooling in the North Atlantic, 3) collapse of the Laurentide ice sheet and 4) a sudden increase of icebergs into the Atlantic Ocean. The net effect is to cool the ocean surface waters and decrease thermohaline circulation (differential density-driven convection related to water temperature and salinity). This cooling puts an end to the iceberg production, causes a warming trend and restoration of thermohaline circulation (Clark and Bartlein, 1995)

The Younger Dryas is broadly dated to between 11 and 10 KBP, but recent research suggests that the actual timing of the event may be more tightly constrained between 10.6 to 10 KBP (Bjork et al., 1996; Mangerud et al., 1974).

Various proxy paleoclimatic indicators are utilized to infer global cooling during the Younger Dryas times, including sediment production (Beget, 1996; Bigelow et al., 1990; Bull, 1980) measurement of atmospheric 14C content (Hajdas et al., 1998) fossilized benthic foraminifera (Mathewes, 1993), Glacial lake-level (Oviatt, 1997) and fossil pollen studies (Peteet, 1992).

The glacial record is important for identifying Younger Dryas cooling because Alpine-type glacial advances may occur rapidly in response to climatic change. Several studies place the timing of relatively small but nonetheless significant glacial advances in the western states. Osborn and Gerloff (1997) dated the Crowfoot glacial advance to within the Younger Dryas time frame. A greater extrapolation of similar data throughout the American Cordilleran supports the same (Osborn et al., 1995). The primary contribution of Osborn's work to identifying the Younger Dryas alpine glacial signature is the presentation of an important geomorphic relationship--that of pre-little ice age (LIA) cirque and valley-head moraines located between 1-5 km beyond the LIA moraines. The Crowfoot moraine displays this relationship and it is compared to numerous such moraines reported in Waitt et al., (1982) from the Cascades in Washington State. The key problem with assigning a Younger Dryas age to the moraines is that of dating. Currently, the timing of glacial advance for the Cascade moraines can only be bracketed between deglaciation of the Alpine valleys (~15 to 12 KBP) and Mazama tephra deposition 6.7 KBP (Osborn et al., 1995). Further research is necessary to determine the timing of moraine emplacement.

Doerner and Carrara, (1999) describe fossil pollen sequences from similar cirque settings in the West Mountains of west central Idaho that support a Younger Dryas cold period. They describe generalized temperature increases associated with post-glacial climatic amelioration during the period 11.5 KBP to 9.8 KBP and report only a minor fluctuation to cold-loving pollens ~10.4 KBP.

Gosse et al., (1995) present unique evidence for Younger Dryas cooling utilizing moraine deposits. Working with accelerator mass spectrometric measurements of $^{10}$BE from granitic surface boulders, the authors present a case for Younger Dryas age deposition of boulders in the moraine. The authors suggest that $^{10}$BE is a productive alternative method over conventional radiocarbon dating because it is determined by timing of surface exposure to cosmic radiation utilizing exceedingly stable minerals such as quartz. Where materials suitable for radiocarbon analysis may not be readily available in the North Cascades, granitic rocks are present in the suspect moraines and this chronometric method may be applied.

Clark and Bartlein, (1995) present an in-phase correlation of Heinrich events with Cordilleran and Alpine glaciation in the Puget lowland and possibly in the Cascades. Evidence for an in-phase advance of the Puget lobe however is sparse, with only a minor period of glacial re-advance that is dominated by a trend towards deglaciation by 11.4 KBP. It should be noted that these authors cite Armstrong, (1981) as the source of chronological information. Numerous advances in dating methods have arisen in the intervening two decades; more recent dating tends to support an in-phase glacial advance (Easterbrook and Kovanen, 1998; Kovanen 1996).

Easterbrook and Kovanen (1998); Easterbrook (1992) and Kovanen, (1996) present evidence for a Younger Dryas-age advance of the Sumas glacier on the Puget lowland. This evidence is disputed by Clague et al., (1997) and Clague et al., (1998) based on differing interpretations of the definition of the Sumas glacial drift. In particular, the depositional environment of associated sediments and the possibility that Sumas glacial till might reflect a protracted glacial stillstand rather than a Sumas re-advance is argued. Despite the details, the authors agree that there is an apparent post-11 KBP glacial signature with an associated retreat at some point just prior to 10 KBP.

Alluvial response to the Younger Dryas is reported as overall reduced flow at a site on the Dutch-Belgian border (Vanderberghe, 1986), and at the other end of the spectrum, a 'flood period' (Smith, 1992). Research on the Kersey-Kuner terrace in the American southwest suggests that Alpine glacial response may have left a distinct alluvial record during Younger Dryas times. The effects of Younger Dryas there are characterized by a post-glacial depositional hiatus and down-cutting event during a return to a cold Younger Dryas-age climate, followed by an immediately post-Younger Dryas alluvial fill that emplaced an inset terrace (Haynes et al., 1998).

The record of alluvial response to Younger Dryas climate change in the Northwest is not directly reported in the literature, but several lines of evidence suggest that there is a record of Younger Dryas deposition along the mainstream Columbia River. Gough, 1995 reports a thick (>2m) section of Glacier Peak tephra reworked by catastrophic floods near Orondo, Washington. Glacier Peak tephra is known to have erupted at some point near 11.6 KBP (Mehringer and Foit, 1990). This places the timing of the large flood at some point after the eruption of Glacier Peak. Because the site lies at a topographic point significantly higher than the modern river, late Pleistocene non-megaflood alluvium is not the source of the flood event. Waitt et al., (1989) mapped an interrupted post-Glacier Peak Pleistocene/early Holocene flood terrace, unit Qfy (Quaternary fluvial young), at a topographic location higher than the early Holocene terrace deposition, but lower than and displaying an inset relationship to megaflood deposits. Russell and Marren, (1998) report a similar YD age jokulhlaup deposit in Scotland. It is likely that both Gough and Waitt's reflect YD age deposition (see alluvial chronology section in this chapter for a more specific discussion). At West Bar near Trinidad, Washington, I have mapped an alluvial terrace that is topographically lower than catastrophic outwash flood deposits, but significantly higher than the early Holocene terrace. This terrace may relate to a Younger Dryas return to a cold climate.

Many palynological studies are undertaken on lacustrine sediment cores (Doerner and Carrara, 1999; Grigg and Whitlock, 1998; Mathewes et al., 1993). Engstrom et al., (1990) include a discussion of stratigraphic change that accompanies climatic fluctuation at Pleasant Island Lake, British Columbia. The authors observed stratigraphic changes in sediment chemistry through the lake soil profile. Buried soils in the lake core display a distinct loss of organic input that correlates to periods of pollen flux. Specifically, as tundra-type pollens replace forest (pine) pollen, organic input is at a minimum. Conversely, as forest pollens return to dominance in the stratigraphic section, organic input increases and the clastic sediment component decreases (Engstrom et al., 1990). The period of maximum sediment flux recorded in the Lake sediments is dated between 10.8 KBP and 9.8 KBP, thus showing a strong correlation to reported YD events elsewhere.

Looking at the record of lake level fluctuation at Glacial Lake Bonneville, which extended into the southern portion of Idaho during the Wisconsin, Oviatt (1997) reports lacustrine evidence for climatic change during the YD period. Utilizing geochemistry and mineralogy of deep-water carbonates together with stratigraphic studies of the shoreline, the author interprets numerous millennial-scale fluctuations of the Lake shoreline, including a major lake-fall during the YD.

Because it is able to accumulate in deep continuous deposits over thousands of years, loess is an effective paleoclimatic indicator. On the Columbia Plateau, loess covers huge areas and provides a nearly continuous climatic record, possibly into the Upper Pliocene (Busacca and MacDonald, 1994). Bigelow et al., 1990 recorded a sharp increase in grain particle size in loess at the Nenana River in Central Alaska (silt to sand). The authors interpreted the sand as an increase in wind intensity and dated the sand emplacement roughly coeval in time with the Younger Dryas, between 11.1 and 10.7 KBP. In addition to the increased sand in the stratigraphic section, soil formation slowed or stopped and there was a marked decrease in pollen influx during the same period of time. Beget, 1996 reports similar data from sites across Alaska. In the central Columbia Plateau, the Bishop Geosol (Chapter 4) is buried by a Younger Dryas eolian deposit that is consistent with the Alaskan Younger Dryas data.

A marine record that supports Younger Dryas cooling is sparse. Patterson (1993) looked at marine sediment cores off the coast of British Columbia to reconstruct the climatic history immediately following deglaciation. He reports that based on the presence of foraminiferal indicator species, deglaciation was complete by 12.2 KBP. Water temperatures increased shortly after full deglaciation (evidenced by low proportions of *Cassidulina reniforme*) and reverted to near maximum cooling conditions (evidenced by high proportions of the same creature) between about 10.1 and 11.3 KBP (Patterson, 1993). Mathewes (1993) present the same evidence with similarly dated maximum frequencies of *Cassidulina reniforme* between (10.2 and 11 KBP at Queen Charlotte Island and Marion Lake, British Columbia.

Mathewes et al. (1993) identifies pollen shifts represented in two sediment cores from the Queen Charlotte Islands. Both cores exhibit a change from forest-type pollen to herb-rich pollen soon after 11.1 KBP. Similarly, Mathewes (1993) identifies evidence for a post-glacial climatic reversal between 10.7 and 10 KBP. This is based on numerous pollen peaks of mountain hemlock (Tsuga mertensiana), a reported indicator of cool, moist climates, coupled with evidence for a shift from forest-type to non-arboreal vegetation.

Grigg and Whitlock (1998) report a shift from pre-Younger Dryas age *Pseudotsuga* (warm climate) pollen and charcoal changing to subalpine forest (indicated by increased haploxylon *Pinus*) during the YD time frame at Little and Gordon lakes in western Oregon. Around 10 KBP a reversal back to *Pseudotsuga* took place.

Engstrom et al., (1990) report a climatic reversal (see Lacustrine Record above) represented by changing pollen frequencies at Pleasant Island Lake during the Younger Dryas period. The climatic reversal is interpreted by a record of pine-dominated vegetation being replaced by tundra-type vegetation, returning to pine-domination between the period 10.8 KBP and 9.8 KBP.

Not all of the palynological data reflects Younger Dryas climatic conditions. Working in the West Mountains of west-central Idaho, Doerner and Carrara (1999) report a generalized warming trend punctuated only very briefly by relatively cold species. They report a generalized spruce-pine forest surrounding the Van Wyck cirque around 11.5 KBP. For a short period ca. 10.4 KBP there is a decline in the pollen influx rates, organics and in the Pinus/Artemesia ratio (artemesia peaks during this brief period).

The effects that the Younger Dryas event may have had on human occupations in the region include direct effects, for instance, that landforms available for occupation in the immediate post-glacial period would have been eroded when the environment warmed and river flow increased. Thus, evidence for Colonizer-age occupations would be found away from the primary channel and outside of the braided river system that existed in immediate post-glacial times. Indirect effects may include Colonizer response to vegetation reorganization as a result of climate change and an overall change in landscape use, particularly if the effects of seasonality were amplified during the Younger Dryas.

## Alluvial Chronology

Alluvial terraces represent former river floodplains that were abandoned as their river base level changed. This base level change forced downcutting into the alluvium, leaving the former floodplain at a higher topographic elevation than the active floodplain. On abandonment of the sediment-depositing river, landform stability allows pedogenesis to ensue. On Pacific Northwest Rivers, aggradation and degradation periods that are recorded in the former floodplains are relatively easy to interpret due to the abundance of stratigraphic marker horizons in the alluvium. Archaeological material is buried in the alluvium, leaving behind a rich record of activity. Archaeological site density throughout the Pacific Northwest region is highest on the alluvial terraces.

A relatively small number of authors have conducted research on the alluvial systems of Pacific Northwest Rivers. On the mainstream Columbia and Snake Rivers, Chatters and Hoover (1986, 1992) studied the relationships of changing post-glacial and Holocene climates and aggradation episodes at an archaeological site on the upper Columbia River. Fecht and Marceau (2006a, b) produced a comprehensive alluvial chronology for the Hanford Nuclear site on the middle Columbia River. Hammatt (1977) presented broad overviews of alluvial chronology and geomorphology along a portion of the Snake River in Washington State. Chronologies of the tributary drainages to these primary waterways are considered by Cochran (1977; 1988) who developed a chronology for Johnson Canyon in central Washington and a comprehensive alluvial chronology for small rivers and streams in eastern Montana, western Idaho and eastern Oregon. Just south of Cochran’s work in Johnson Canyon, Galm et al. (2000) studied drainages of the U.S. Army Yakima Training Center, describing a 4-cycle chronology spanning the upper Pleistocene through the Holocene. Huckleberry (2003) investigated four streams in the Palouse River watershed: Imbler, Rebel Flat, Willow, and Alkali Flat creeks, which appear out of phase with other regional streams. West of the Cascade Range, Beechie et al. (2001) present details of alluvial chronology and geomorphology along the Puget Lowland drainages. Despite this broad range of work across the region, no attempt at synthesizing the drainage chronologies has so far been undertaken.

### West side of the Cascade Range

Following retreat of the Puget lobe of the Cordilleran glacier, the Colonizer land surface was much lower than the present day, and the isostatic load continued to modify the landscape. In the northern Puget Sound where the effects of the glacial load had depressed the underlying sediments, isostatic rebound followed close behind; as much as 200m of elevation change took place in the northern Puget Lowland (Figure 3.20; Thorson 1989). Subsequent deglacial sea level rise transformed the valley bottoms (Booth et al. (2004).

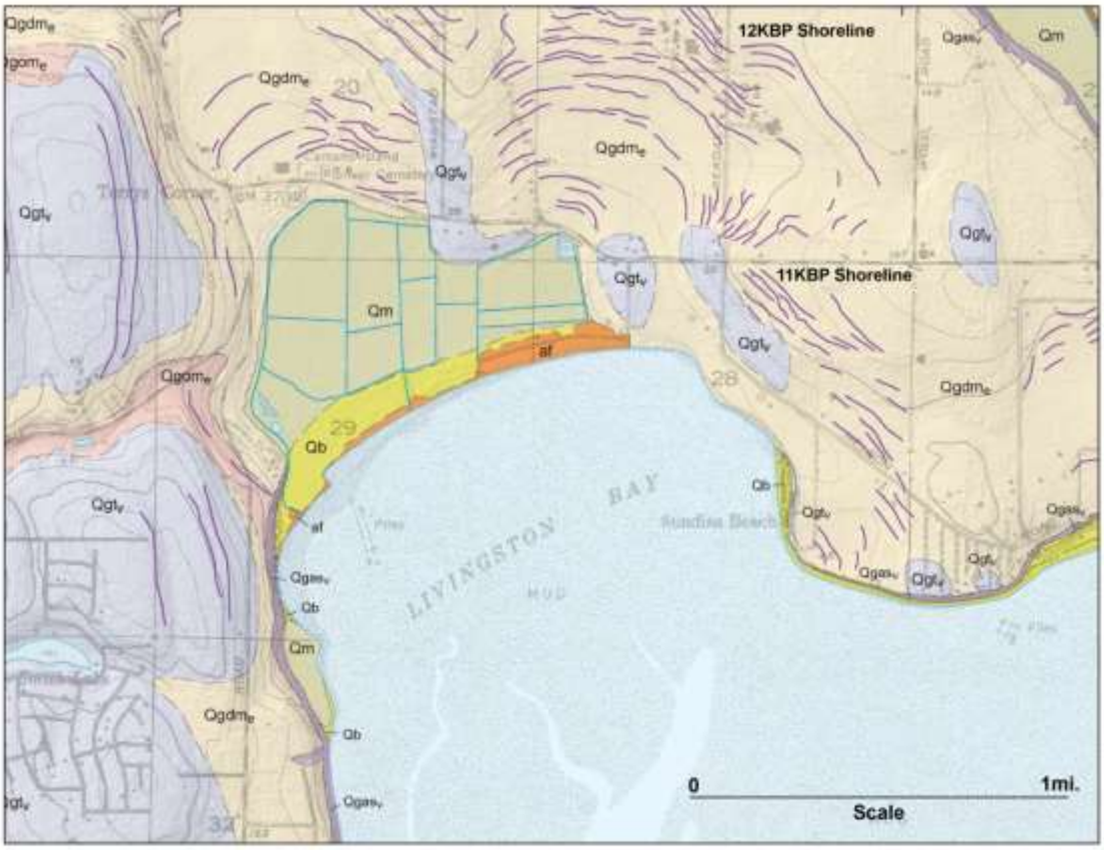


Figure 3.20 Upper Pleistocene strand lines (former beaches), the result of isostatic rebound, Camano Island, Washington State. Former beaches indicated as solid purple lines, interpreted from LIDAR mapping.

As ice-sheets retreated, opening the Strait of Juan de Fuca and Admiralty inlets, marine waters related to global, deglacial sea-level rise entered the Puget Sound. Base level changes accompanied the rapid isostatic rebound. As rivers and streams that flowed into the Puget Sound incised into the glacial sediments between 16 KBP and 12.5 KBP, former floodplains were terraced along the main valleys, creating a series of terrace steps (Figure 3.21). During this time, isostatic rebound outpaced sea level rise along the lower Puget Sound valleys. This caused River mouths to move in the down-valley direction. At Arlington, the valley floor rose about 70m, and at Lyman, the Skagit valley rose 75m (Beechie et al. 2001). During this time the Puget Sound river mouths were situated between 5-20 miles upstream from their present location.

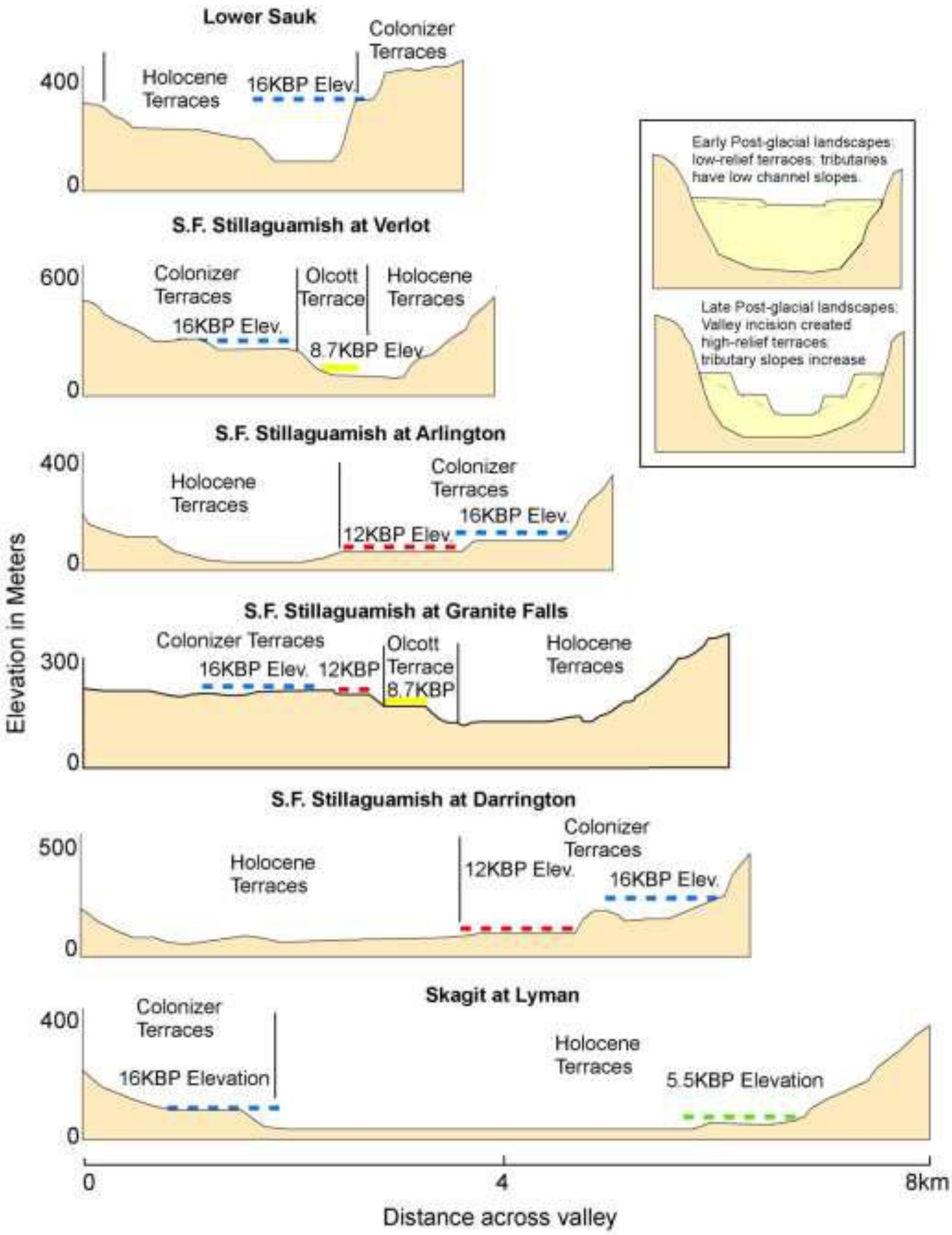


Figure 3.21 Stillaguamish River isostatic terrace steps (after Beechie et al. 2001).

Beechie et al. (2001) hypothesize that, due to increased slopes caused by the base level changes during isostatic adjustment, the usable stream for fish habitat was minimized. While the availability of anadromous fish may have been poor, Colonizers appear to have utilized the rebounding landscapes nonetheless, as their sites are located along the terrace steps (Chapter 6).

**12.5 to 5.5 KBP**

After 12.5 KBP, while isostatic uplift and river incision appear to have decreased overall, uplift continued to outpace incision. As a result, valley floors rose more slowly, and valley floor elevations relative to sea level were typically stable or decreasing. Incision of the Puget Sound Rivers by 5.5 KBP approximately matched the rate of uplift while sea level continued to rise. As a result, Rivers moved in the up-valley direction while the Puget Sound flooded its lower reaches.

**East of the Cascade Range**

Maximum extension of the Cordilleran ice sheet into the Columbia Plateau took place between 17-15 KBP (Atwater 1984; Clague et al. 1980; Easterbrook 1992; Waitt and Thorson 1983). This was followed by rapid glacial wasting, filling the Columbia River system with coarse sediment and high flows, terminating by 13 KBP. As a result of the significant quantity of sediment bedload that entered the Columbia River system due to the Pleistocene megafloods, at the close of the Pleistocene the Columbia River plain formed a braided system of channels (Figure 3.22). The transition from this braided system to that of the present day is not well understood--particularly unclear are details of the effect of the Younger Dryas cold reversal on alluvial sedimentation. What is clear is that, as water flow waned, sediment bodies that choked the Columbia River trench were ultimately incised.

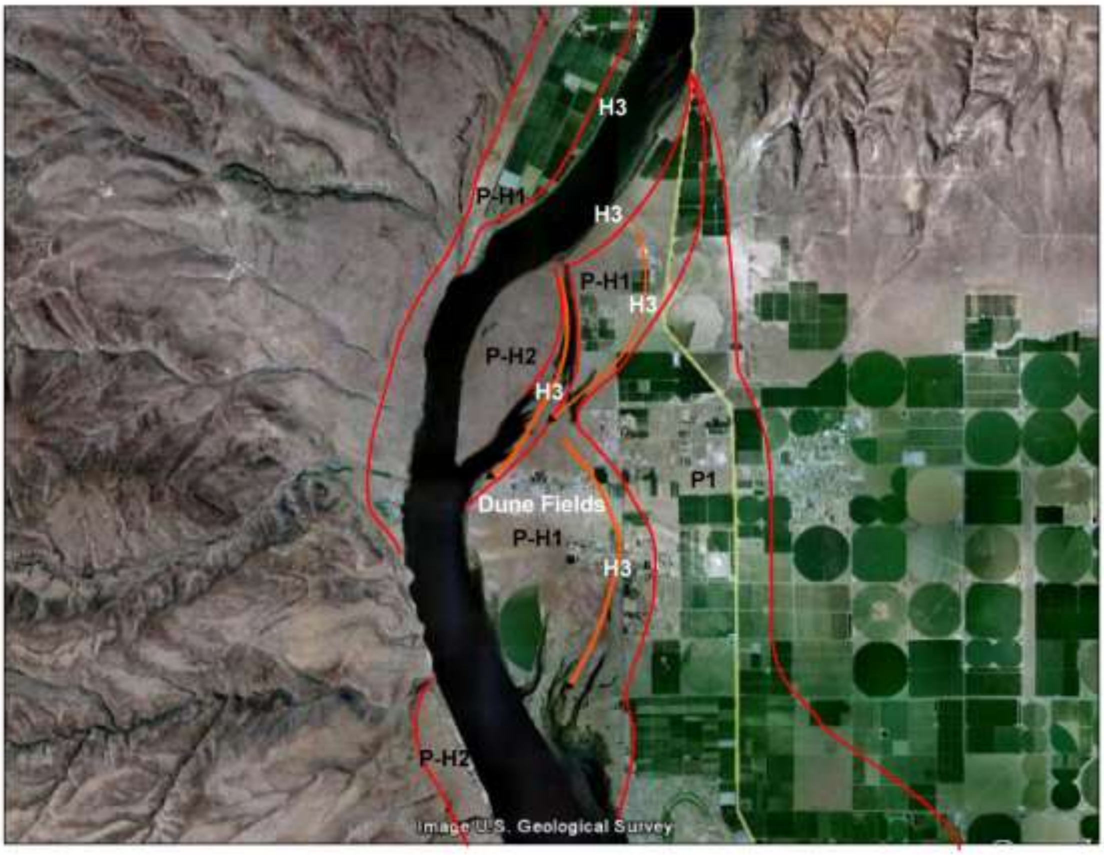


Figure 3.22 Upper Pleistocene to earliest Holocene braidplain geomorphology, Columbia River near Mattawa, Washington State.

The configuration of the Upper Pleistocene Columbia River was transformed in a dramatic way Figure 3.23. The accompanying base level change also lowered the base levels of the primary tributaries by 12.4 KBP (Atwater 1984).

On the tributaries, sedimentation is episodic during the late Pleistocene-early Holocene with alluvial episodes burying stable soil surfaces (Galm et al. 2000; Huckleberry 2003). Tributary streams of the central to western portion of the Columbia Plateau such as Cow and Crab Creeks and those in the Palouse are comprised of silty sand, overlying coarse gravels which often lie unconformably on scoured basalt.

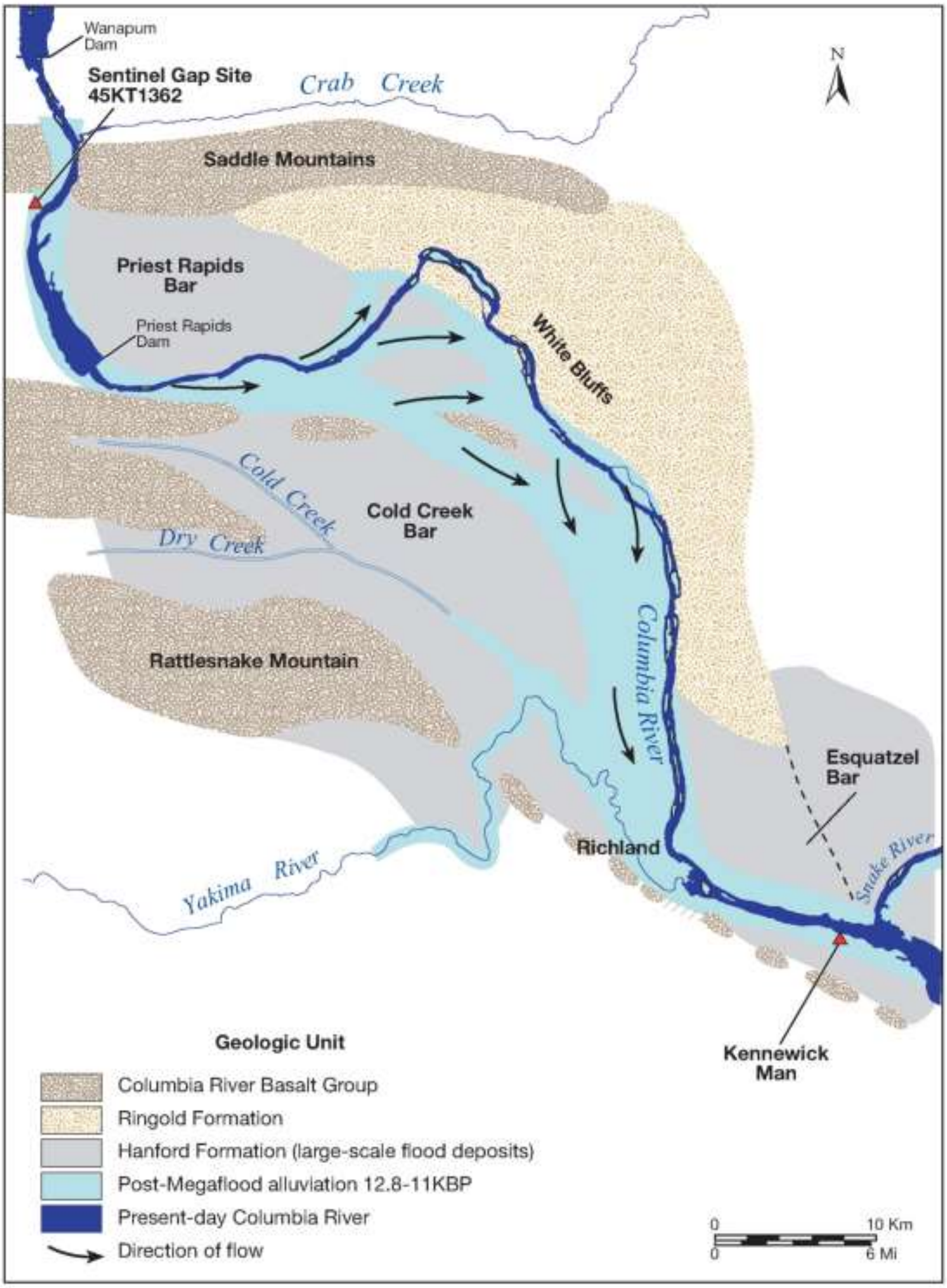


Figure 3.23 Columbia River system at close of Pleistocene. Holocene (Modern River) is indicated in dark blue (After Fecht and Marceau 2006).

The relative few alluvial chronologies that have been developed for Pacific Northwest Rivers and streams clearly indicate that periods of aggradation are synchronous in time, suggesting a regional response to climate flux. The single outlier to this trend is the Palouse system which appears to have unique geologic and landscape characteristics that precluded terracing, providing a stable sedimentary environment since the close of the Pleistocene (Huckleberry 2003). The regional post-megaflood alluvial chronologies developed for the northwest rivers and streams are typically subdivided into alluvial "cycles", which begin with aggradation and end in terracing and soil development on the terrace surfaces.

**Alluvial Cycling**

Hammatt (1977) was the first to describe alluvial cycles along the Snake River in eastern Washington State. Hammat describes two cycles; cycle 1 correlates to that of Cochran (1988), who described four alluvial cycles in Oregon, Idaho and Montana, recognizing broad episodes of alluvial cycling with apparent periodicity on the order of 2-4 thousand years. Galm et al. (2000) described four cycles, again, broadly correlating to other regional sequences.

Hammat (1977) and Galm et al. (2000) describe the components of alluvial cycles, which essentially include details of the alluvial process from initial floodplain construction through abandonment and terracing. The cycle begins with aggradation along the channel margins. High volume seasonal floods drop their load across the surface of the floodplain. Erosion, deposition of dune sands and reworking of both between flood events occurs, but these deposits are rapidly covered by annual flooding. Riparian vegetation during this phase of flooding is restricted to the upper margins of the alluvial floodplain, away from the channel areas that are subject to scouring and erosion. Towards the end of the alluvial construction period, riparian vegetation takes hold and soil development outpaces active sedimentation. Base level change occurs at the end of the cycle and the floodplain is terraced. Dune deposits form along the terrace surface, mantling the terrace tread. As the water table is lowered, carbonates precipitate out of the inactive B horizons. One relatively minor distinction is clear between the two descriptions; while Galm et al. describe the overall process, Hammat's description requires that pedogenesis is restricted to the relatively short post-aggradation period.

During the late Pleistocene through the Holocene these alluvial cycles led to the formation of two to five geomorphic terraces on the Snake and Columbia Rivers and their tributaries. In most cases the cycles appear to be correlated across the region; I will present them as Aggradations 1-5, with primary emphasis on Aggradations 1 and 2 as they are the most extensive at topographic elevations above mainstream reservoir impoundments and the aggradations that formed during the Colonizer period (Figure 3.29). In the Hanford Reach of the Columbia River, the A1 through A5 aggradations form a set of narrow, downward stepping terrace benches. The Hanford Reach is one of few places along the mainstream Columbia River where the terrace sequence is not inundated by impounded reservoirs.

**Aggradation Period 1: 12.8-10 KBP: Transition to the Holocene**

On the western margin of the Columbia Plateau, along the middle Columbia River, megaflood deposits are flanked by coarse (gravel to cobble) to fine-grained (silty sand) alluvium, distinct in character, with inset relationships to the megaflood bars and terraces. Between 12.8 KBP and 10 KBP, distinct landforms were emplaced at a topographic setting between the megaflood deposits and the later Holocene terraces. This transition from the upper Pleistocene to the Holocene is marked by a change in alluvial architecture from a broad, braided plain to an entrenched, single river channel that is filled by the (relatively) fine-grained Holocene terraced sediments. This entrenched stream has persisted for 10,000 years.

Together, terrace steps that formed during this transition represent a Holocene alluvial system that was still highly influenced by glacial sediment from the retreat of the continental ice sheet. A glacial re-advance (Younger Dryas; Clark and Lear 1992; Clark and Bartlein 1995), is characterized as the coldest of late to post-glacial cold periods that mark the Pleistocene to Holocene transition (Bradley 1999). Environmental response to this cold period is suggested in the interior Pacific Northwest through several lines of evidence noted in the section above, and alluvial deposits appear to have responded in a distinct manner. Along the Columbia River valley, this time period is marked initially by a down-cutting event followed by an immediate alluvial fill that is subsequently terraced as the unstable Pleistocene to Holocene transition proceeds. This same pattern is also known from the Kersey-Kuner terrace in the Rocky Mountains (Haynes et al. 1998). Deposits associated with Younger Dryas deposition are found in the Rocky Reach vicinity of the Columbia River trench, where Glacier Peak ashfall (ca. 11.6 KBP) is found in debris flow deposits near the Chelan Falls area and in outburst flood deposits (Gough 1995). On downstream reaches of the Columbia River they are present at West Bar, near Trinidad on an intermediate-elevation terrace step located between the Upper Pleistocene mega-ripple-marked terrace and the fine-grained early Holocene terrace that includes primary Mazama tephra. The complete series of terrace steps, including the Younger Dryas age terrace is present along the Hanford Reach where Fecht and Marceau (2006b) have grouped this series together, referring to them collectively as the “P-1” and “H1-2” terraces.

The sediments in these terraces mark a change in the compositional assemblages of the sand fraction that was transported and deposited by the Columbia River. Along the Hanford Reach and the Rock Island, Wanapum and Priest Rapids reservoirs, basalt sand dominated the composition of glaciofluvial sediments (Figure 3.24). In the earliest Holocene terraces, composition of the sand fraction returned to quartzofeldspathic sands, a characteristic of the Columbia River sands during preglacial times (Fecht et al. 1985).

In terms of process, as the glacial discharge waned, sediment load and water flow decreased. The net effect was to force the river to abandon the majority of its anastomosing channels and settle into a single, entrenched channel. Although the deeply entrenched Holocene channel is much more restricted in area than the post-megaflood ancestral channel, the upper-Pleistocene drainage scars provided back-water areas that filled with early Holocene sandy alluvium during the early Holocene aggradation (termed A2 below). These former secondary channels, as well as bank-attached and mid-channel bars are now the shoreline at reservoir impoundments along the middle Columbia River, and they often contain buried early Holocene archaeological sites.

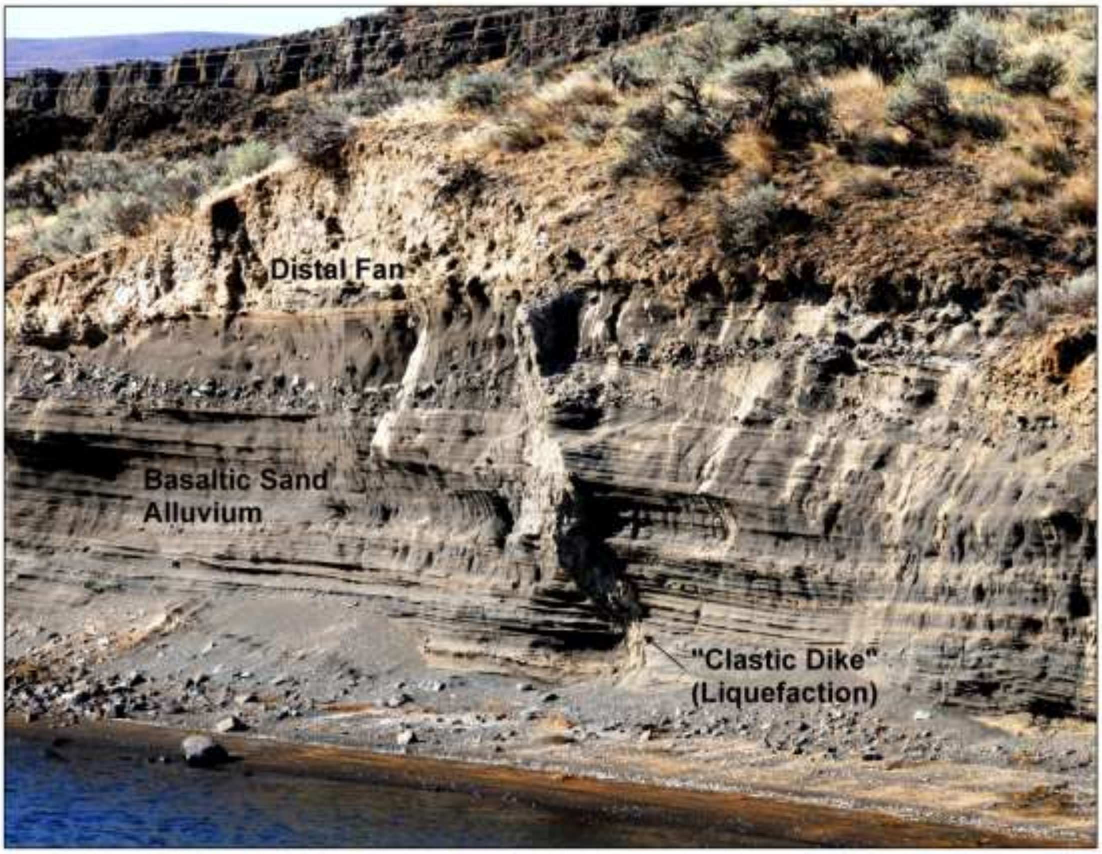


Figure 3.24 Glaciofluvial basaltic sand alluvium, Columbia River at Vantage, Washington State

Along the Columbia River these transitional terraces are characterized by a broad, undulating, gently sloping, pebble-to-cobble gravel clast landforms with treads that contain channel and bar bedforms. The H1-2 terraces lie between 6-12 m above the low water level of the pre-dam Columbia River. The remnants of these terraces have poorly defined margins and gentle lower valley slopes, but they are well defined in areas with moderately steep slopes along the Hanford Reach (Fecht and Marceau 2006b). In many areas the terrace margins and treads are masked by eolian dunes that have buried portions of the Middle Columbia terrace system. The extensive dune fields near Mattawa, Washington and north of Richland, Washington cover earliest Holocene terraces (Figure 3.22).

At the U.S. Army Yakima Training Center (hereinafter YTC; Cochran 1977; Galm et al. 2000), and in the Black Rock Valley (this work), initiation of the A1 is considered to begin prior to eruption of Glacier Peak and Mt. St. Helens Set J tephras. The age of the Pleistocene/Holocene boundary depositional episodes of A1 are not directly dated, but they must post-date the final cross-scabland megaflood (12.8 KBP; this work) while pre-dating deposition of the Glacier Peak tephra (11.6 KBP; Gough 1995) and they must be older than the initiation of the A2. Radiocarbon dates from the Hanford Reach suggest that deposition of the A2 terrace must predate 9.3 KBP (Fecht and Marceau 2006b) and more recent dates as a result of the present work on the mainstream Columbia River suggest an even earlier bounding date of 10,350 ± 60 (Beta 277407). The net effect of the transition to the Holocene alluvial type was to emplace a tremendous amount of sediment over a period not much greater than 2000 years in length. The terminal Pleistocene and earliest portion of the Holocene was a period of extreme instability along the regional rivers. The effect that this initial aggradation period may have had on human occupations is that landforms available for occupation in the immediate post-glacial period may have been eroded when the environment warmed and river flow increased. Thus, evidence for Colonizer age occupations would be found away from the primary channel and outside of the braided river system that would have existed in immediate post-glacial times.

**Aggradation Period 2: 10.5-7 KBP**

This period of alluvial construction followed close behind the climatic transition from the Pleistocene to the Holocene Period. The A2 Terrace is ubiquitous to the impounded reservoirs of the Columbia River system; where it is recognized by archaeologists, it is reported at discontiguous locations along the Columbia River drainage from the Chief Joseph Reservoir through at least the McNary Reservoir area (Chatters and Hoover, 1986, 1992; Huckleberry et al., 1998; Meirendorf, 1983). Along the middle Columbia River it is present as the reservoir streambank across the extent of the Chief Joseph, Wells, Rocky Reach, Rock Island, Priest Rapids, Wanapum and McNary Reservoirs and along the entirety of the Hanford Reach (Figure 3.29). The correlative terrace in the Snake River system is present more than 20 meters in elevation above the modern Snake River flood plain (Hammat, 1977). A significant amount of fieldwork has been concentrated on the age of this terrace as a result of recent studies at Columbia Park, the find spot of the Kennewick Man skeleton (Huckleberry et al., 1998; Huckleberry and Stein, 1999).

The A2 Terrace includes a compact sequence of fine-grained sediments. Along the main stream Columbia River, alluvium is planar-bedded and normally graded. The total thickness of the alluvium varies by drainage, on average it ranges between 2-5 meters in total thickness. Generally, the initiation of the A2 aggradation is dated between 10 and 9 KBP, and radiocarbon dates from overbank alluvium of the A2 Terrace range from at least 10,350 ±60 (Beta 277407; this work) to 6,840 ±100 (Fecht and Marceau 2006b; GX-26058). Stratigraphic studies show that the A2 terrace has an eolian cap that includes Mazama tephra; some exposures of Mazama contain alluvially reworked tephra from exceedingly high floods, but no alluvial units are known to bury the tephra. Along the Hanford Reach, the oldest date in eolian sediments from the terrace is 7 KBP (Fecht and Marceau (2006b). In the Priest Rapids reservoir, a prehistoric shell midden in alluvium with an age of 7.8 KBP stratigraphically underlies a midden in the eolian cap with an age of 4.9 KBP (Beery et al. 2002), providing a tight correlation with the Hanford Reach date. The eolian cap continues to the surface, in places a weak, late Holocene Paleosol (Willow Lake Paleosol, Chapter 4) has formed and the entire sequence is capped by the modern surface soil with Mt. St. Helens 1980 tephra.

The A2 terrace is particularly well represented along the main stream Columbia and Snake Rivers. In stark contrast, Huckleberry (2003) reports that streams along the Palouse drainage have no evidence of alluvial downcutting and terracing. Huckleberry’s data from the Palouse watershed suggests that Palouse tributary streams remained stable (containing a single valley fill) from the deposition of slackwater megaflood sediments after the final cross-scabland flood, throughout the Holocene. It wasn’t until Euroamerican agricultural practices caused a major downcutting event just over one hundred years ago that any change in alluvial character occurred. In contrast, alluvial terraces are present below the Marmes rockshelter at the mouth of the Palouse River (Hammatt, 1977; Marshall, 1971), a fact that Huckleberry attributes to changing base level conditions that are controlled by local geologic phenomena.

The primary drainages of the Columbia and Snake River systems indicate clear, in-phase alluvial cycling across the same time range. Huckleberry (2003) notes that while climatic variability affected all alluvial systems in the region, the differences in geomorphic factors such as basin area, lithology and elevation may provide a unique response along individual drainages. As a result, while region-wide aggradation and erosion cycles occur on similar time scales, at least on the Palouse, they appear to be out of phase between the broadly differing drainage systems. It is possible that initiation of the A1 during the upper Pleistocene at the Yakima Training Center is also an example of an out-of-phase relationship, as the Black Rock Creek drainage immediately south of YTC has a clear upper Pleistocene terrace, as described below.

Hallett Hammat (1977) was the first researcher to describe Aggradation 2 deposits along the Snake River drainage. In Hammat's scheme, Aggradation 2 is represented by his "High Terrace", an early Holocene landform located approximately 23 meters above the modern Snake River channel. Hammat deduced that the High Terrace began aggrading around 10 KBP, terminating and terracing around 8 KBP. Soil formation on the terrace is concurrent with alluviation and correlates to the Badger Mountain geosol (Chapter 4). The High Terrace is capped by eolian sediment and dune deposition.

Cochran (1988) recognized four cycles of alluvial construction on three drainages in eastern Oregon and western Idaho and Montana (Figure 3.25). Like the YTC, Cochran describes the first cycle as initiating around 11.2 KBP. Similarities in alluvial construction are clear between the three drainages as each of the alluvial units has a gravelly base with a sandy alluvial cap and a calcic paleosol on its surface. Like the other drainages, this sequence is capped by an unconformity and buried by Mazama tephra.

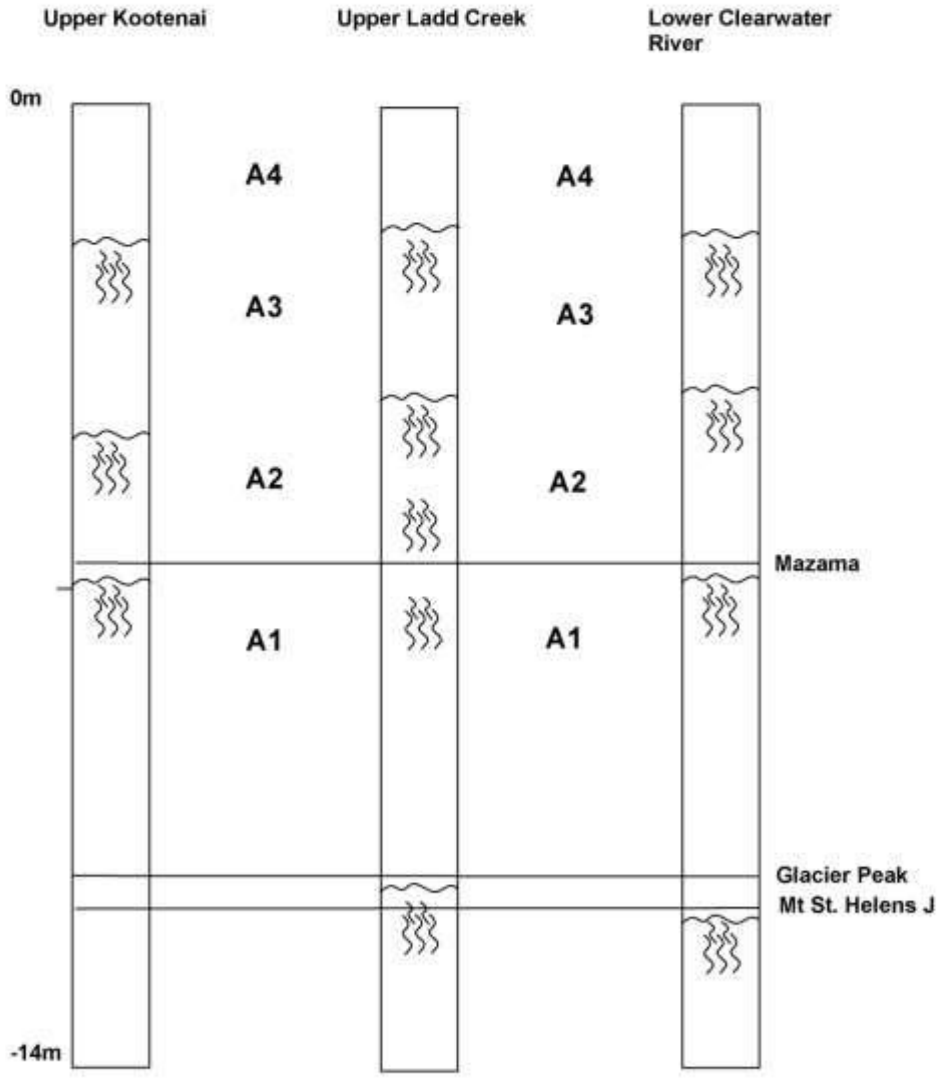


Figure 3.25 Alluvial cycles in the eastern Columbia Plateau (after Cochran 1988). Cycles presented here reflect Cochran's naming convention.

In terms of its relationship to archaeology, Kennewick Man eroded from near the A2 base just downstream from the mouth of the Yakima River. From the Wells Dam near river mile 516 through the Hanford Reach, the A2 terrace forms the reservoir bank. Along portions of the Hanford Reach, the A1 (Pleistocene-earliest Holocene) Terrace is partially hidden behind the A2 Terrace, as its surface is only slightly higher in elevation. In many places, eolian sand sheets and dune colonies have buried the terraces, obscuring them Figure 3.22).

## Middle Holocene

Aggradations 3-5 were deposited from middle Holocene times to the present. These aggradations appear to be coincident with broad increases in moisture (Chatters 1998). On the Palouse tributaries, floodplain aggradation continued unabated, with no terracing (Huckleberry 2003)

## Black Rock Creek

Black Rock Creek is located along the western margin of the Columbia Plateau, an extinct tributary to the Yakima River. It is located due south of the Yakima Training Center and occupies the valley immediately south of the Cold Creek drainage reported in Galm et al. (2000). Table 3.4 provides descriptive geologic units for the Black Rock Creek. The key importance of the Black Rock Creek to this dissertation is its location at an elevation above the megaflood-affected valleys towards the Columbia River to the east. Sediments in the valley appear to range from pre-Wisconsin valley fill along the southern margin of the valley (Terrace 4) to modern alluvial floodplain sediments.

Terrace 4 is located 10 meters in elevation overlying Terrace 3 and is not well represented in the valley. A sole exposure exists on the southern side of the valley wall, but exposure of the sediment it contains is rare and access to the deposits is not easy due to the steep valley wall. Sediments that are exposed are weakly but thoroughly indurated with (stage III) carbonate development. Sediment clasts are rounded basalt in a sandy matrix. Age of the terrace is greater than 75 KBP, and could possibly be much older.

### Terrace 3

The Black Rock Creek T3 is a paired terrace, but it is most prominently preserved on the north side of Black Rock creek. Figure 3.26 shows the extent of the terrace within the Black Rock drainage and Figure 3.27 displays a schematic section. The terrace consists of roughly 4-5m of sandy alluvium over over a gravelly base. Unit 1 at the base of the section consists of matrix-supported subangular to subrounded basaltic cobbles and gravel. Slightly more than 4m of sandy alluvium overlies the coarse base. Units 2 and 3 are differentiated by consistence, unit 2 is slightly less cohesive and Unit 3 has slightly higher silt content. A weak calcic soil (the Bishop geosol) is present in Unit 3, the cap of the unit consists of a sandy alluvium that buried the soil, however the contact is incredibly discreet. A tephra couplet is present in Unit 4, the Glacier Peak and Mt. St. Helens tephras. An unconformity caps Unit 4. Unit 5 is an eolian package with a weakly formed surface soil.

### Terrace 2

The Black Rock Creek T2 is a paired terrace with even distribution on both sides of the Black Rock creek. Figure 3.26 shows the extent of the terrace within the Black Rock drainage and Figure 3.28 displays a schematic section. The terrace consists of roughly 3m of sandy alluvium over over a gravelly base. Unit 1 at the base of the section consists of matrix-supported subangular to subrounded basaltic cobbles and gravel. Slightly more than 2m of sandy alluvium overlies the coarse base. Units 2 and 3 are differentiated by texture, Unit 2 is slightly coarser, Unit 3 has slightly higher silt content. A strong calcic soil is present in Unit 3, which is capped by Mazama tephra

(Badger Mountain geosol). Overlying the Mazama is a sandy eolian deposit that buried the paleosol and the tephra. A weak soil formed in Unit 4, a sandy eolian deposit (Willow Lake Paleosol). Unit 5 is eolian sand with the modern soil forming into its cap.

Deposition along the Black Rock Creek was similar in most respects, to alluvial deposits on the Yakima Training Center. A key difference lies in the presence of an upper Pleistocene alluvium (A1-T3) that ceased forming just prior to incision and deposition of the A2 aggradation. In this respect the T3 terrace of the Black Rock Creek is out of phase with Cochran (1977, 1988), and Huckleberry (2003), but in phase with Galm et al. (2000) and Fecht and Marceau 2006a, b). It is likely that local geologic factors play a role in the case of Cochran and Huckleberry’s chronologies, as the remainder of the Holocene alluvial sequence correlates reasonably well to all of the other published sequences (A2-A5).

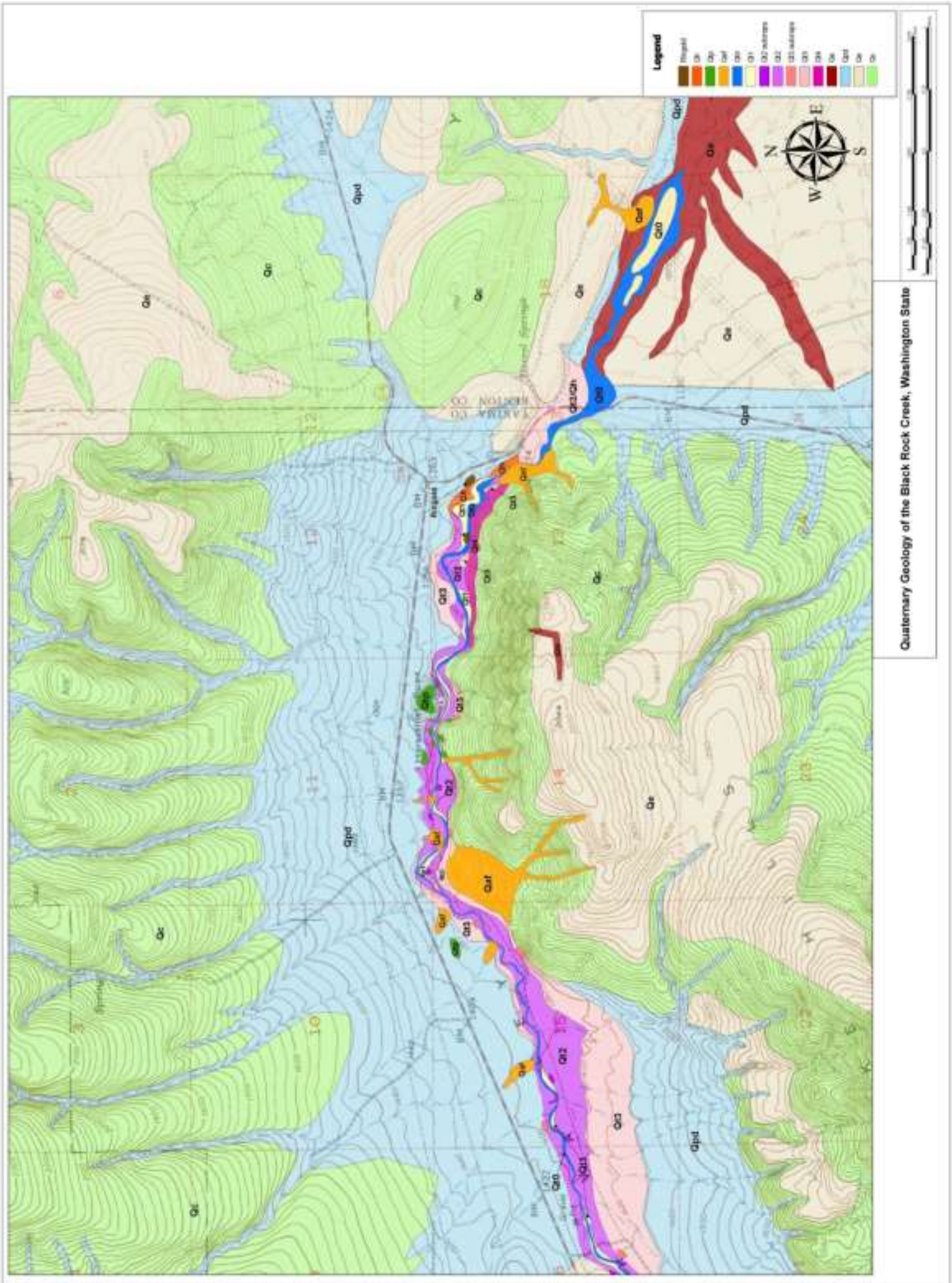


Figure 3.26 Terrace Sequence in Black Rock Valley, Washington State

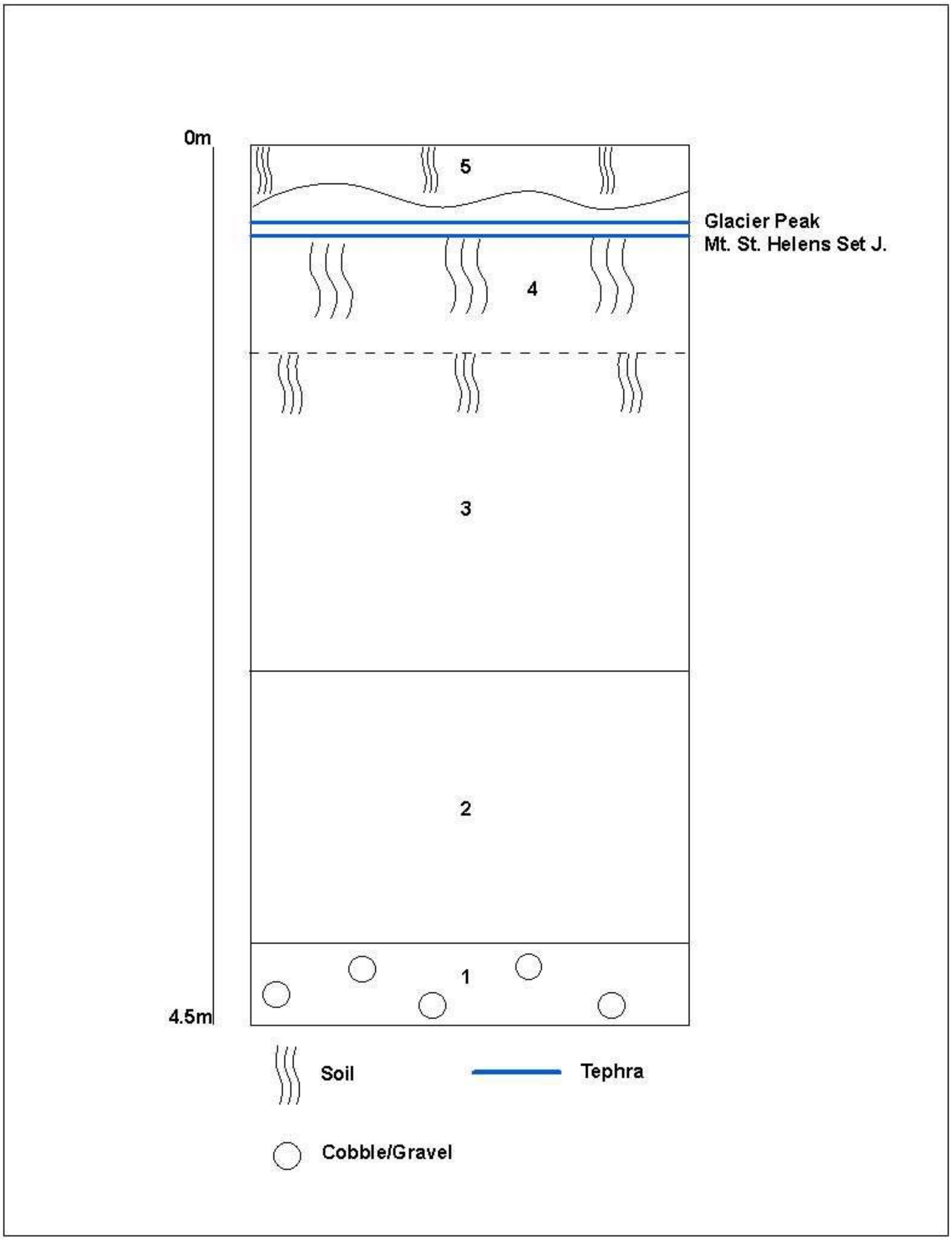


Figure 3.27 Black Rock Creek Schematic T3 Terrace

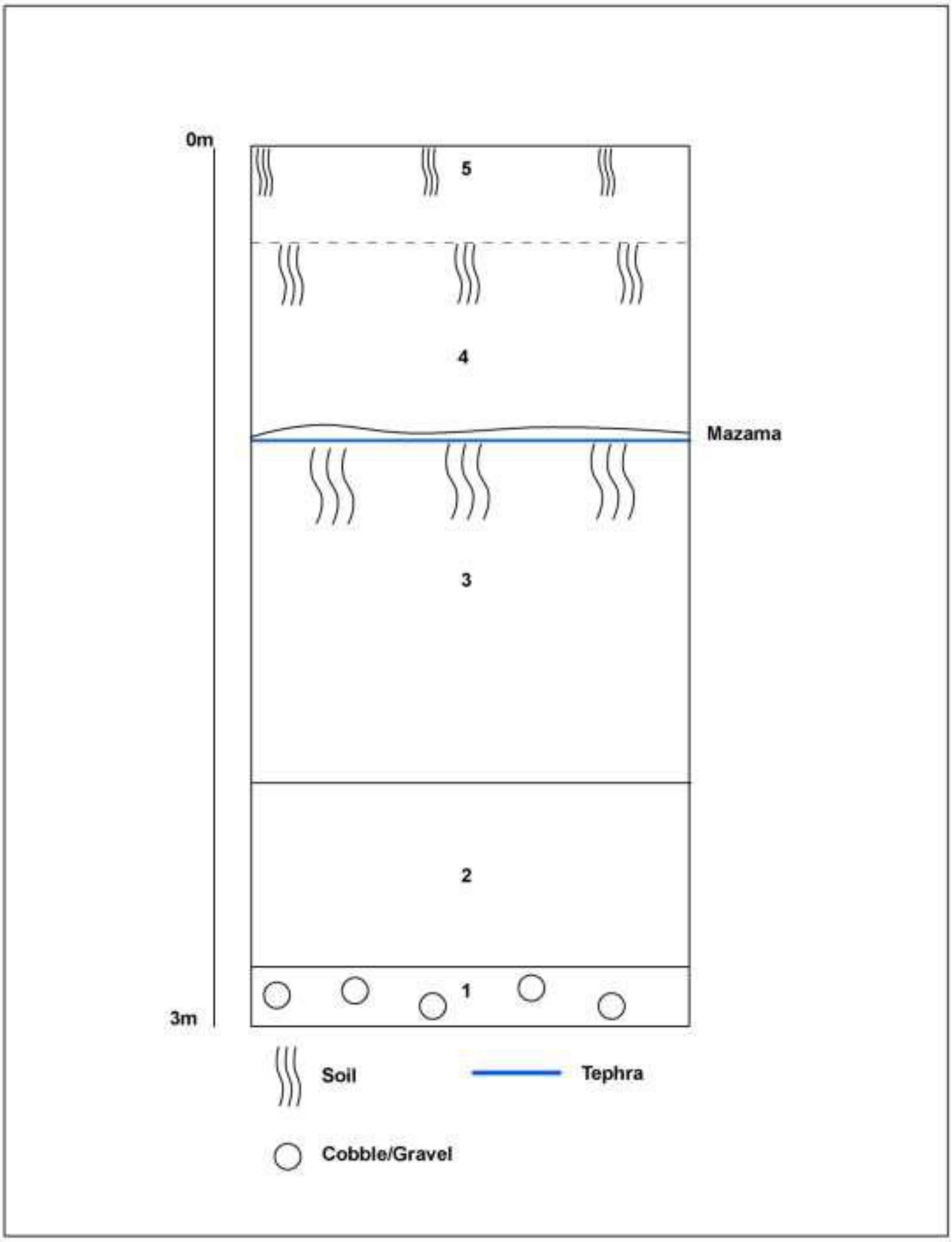


Figure 3.28 Black Rock Creek Terrace 2 Schematic

Terrace 1 is a very thin (<2m) deposit of sand and gravel. No evidence of pedogenesis is present in Terrace 1. Terrace 0, the active floodplain, is a clast-supported sandy gravel alluvium.

## Table 3.4 Geologic Units, Black Rock Creek

**Floodplain Alluvium**- Loose, unconsolidated sedimentary units of Black Rock Valley fill incised into Ringold Formation or unconformably overlying basalt bedrock units within Black Rock Valley. Geomorphic surfaces are generally undissected to very slightly dissected and characterized by active or recently active (Holocene to Pleistocene) sediment accumulation. Differentiated as:

> **T0**-Modern floodplain channel of Black Rock Creek.
> Unconsolidated alluvial channel floor and sidestream deposits comprised of ephemerally-placed basaltic sand, gravel and boulders. Channel floor consists of basaltic grain-to-grain clasts. Non-channel (sidestream) deposits consist of clast-supported gravel and boulders with pockets of sand. Incised and inset into T1- T4 terraces.
>
> **Tl**- Alluvial deposits of silt, sand, and gravel
> Locally includes modem eolian cap; clasts of basaltic composition, very slightly weathered; non-indurated; occurs above modem flood plains; more sand and less gravel than TO. Inset into T2-T4 terraces; age inferred from geomorphology.
>
> **T2**- Alluvial deposits of silt, sand, and gravel; locally includes modem eolian cap; clasts of basaltic composition, very slightly weathered; non-indurated; commonly includes reworked loess and Mazama tephra; early Holocene in age, inferred from geomorphology and tephrochronology; occurs above modem flood plain. More silt, sand and less gravel than Tl. Inset into T3-T4 terraces.
>
> **T3**- Alluvial deposits of silt, sand, and minor gravel, clasts of basaltic composition, very slightly weathered; locally includes modem eolian cap; surficial channels of actively aggrading Qpd are present in places; non-indurated; commonly includes reworked loess, Glacier Peak and Mt. St. Helens Set J tephra; Uppermost Pleistocene in age, inferred from geomorphology and tephrochronology; occurs above modem flood plain. More silt, sand and less gravel than Tl; inset into T4 terrace and older Qpd.
>
> **T4**- Alluvial deposits of ripple-drift and cross-bedded clay, silt and sand; slightly weathered; unidentified tephra present near surface of deposit; pre- Wisconsin in age inferred from geomorphology; occurs more than 10 meters above modem flood plain; weakly indurated to indurated; Inset into older Qpd.

**Qa**- Alluvium Undifferentiated (Holocene)—Silt, sand, and gravel deposits in present-day stream channels, on flood plains, and on terraces; consists of reworked loess (unit Qe; may include small alluvial fans and minor mass-wasting deposits that extend onto the flood plain from tributaries.

**Qpd**- Extensive incised pediment deposits, composed of thin (less than 1.5 m) accumulations of silt, sand, loess, and gravels reworked mainly from the deeply incised Canyons running perpendicular to the front of the Yakima Ridge and from the Ringold Formation; caps and grades into T4 and T3 terraces across the project area; locally capped by loess; weakly to strongly indurated in places; marked by extensive subsurface calcic horizons with moderate to strong Stage IV development.

**Qh**- Glacial flood deposits, sand and gravel (Pleistocene)—Medium to coarse-grained sand and granules with pebbles, cobbles, and boulders; contains beds and lenses of gravel; composed primarily of basaltic detritus from local sources, with minor additions of granitic and metamorphic detritus from sources to the north and east; gray, yellowish gray, or light brown; subangular to subrounded; poorly to moderately well sorted; thin bedded to massive; Slack water and surge sediments from the western margin of impounded glacial Lake Lewis.

**Qe**- Loess (Holocene and Pleistocene)—Silt with lesser amounts of clay; locally includes small amounts of fine sand and volcanic ash; light to medium brown; unstratified; sand and silt composed of angular quartz with lesser amounts of feldspar and mica.

**Mass-wasting deposits**-Sedimentary units that are loosely consolidated non-indurated to slightly indurated and slightly too moderately dissected, including:

> **Qaf**- Sedimentary deposits composed of very minor clay, silt, sand, and rounded to angular basaltic gravel- to boulder-size clasts; in some areas, blanketed with loess; interfingered with colluvium in places; typically displaying high coarse:fine clast ratios. Upper surfaces are capped by very slightly developed soil profiles; commonly capped with pedogenic carbonate. Age inferred from geomorphology, stratigraphic position, pedogenic carbonate development and ages of parent materials.
>
> **Qc**- Unconsolidated to slightly consolidated sandy and pebbly to bouldery deposits that form as colluvial debris aprons (scree and rubble) on hill slopes and at the base of slopes; angular to sub-angular, non-calcareous to weakly calcareous, derived from basalt. Deposit is relatively stabilized in most places; minimal soil development.

**Summary of alluvial data**

The alluvial chronologies of the Pacific Northwest differ significantly from one side of the Cascade Mountain range to the other. In the Puget Lowland, isostatic rebound of the formerly glaciated terrain has led to the development of terraces at unusually high topographic elevations. Upper Pleistocene Colonizer and early Holocene Olcott sites may be found on these surfaces. Correlative terraces in the interior portion of the state include glacial flood terraces which contain some of the earliest archaeological sites. Later terraces contain pithouse depressions at their surface, capping thousands of years of buried archaeology.

Where alluvial chronologies from either side of the Cascade Range differ, similarities in alluvial architecture from one side to the other are clear. At the close of the Pleistocene the influx of glacial sediment choked Pacific Northwest river valleys; alluvial response of the aggrading, meandering rivers was to deposit glacial sediment and build the drainage grades. With glacial retreat, anastomosing, upper Pleistocene and earliest Holocene rivers within the same trench responded to a lower base level by incising into the Pleistocene sediments and depositing deep, fine-grained, inset sediment bodies.

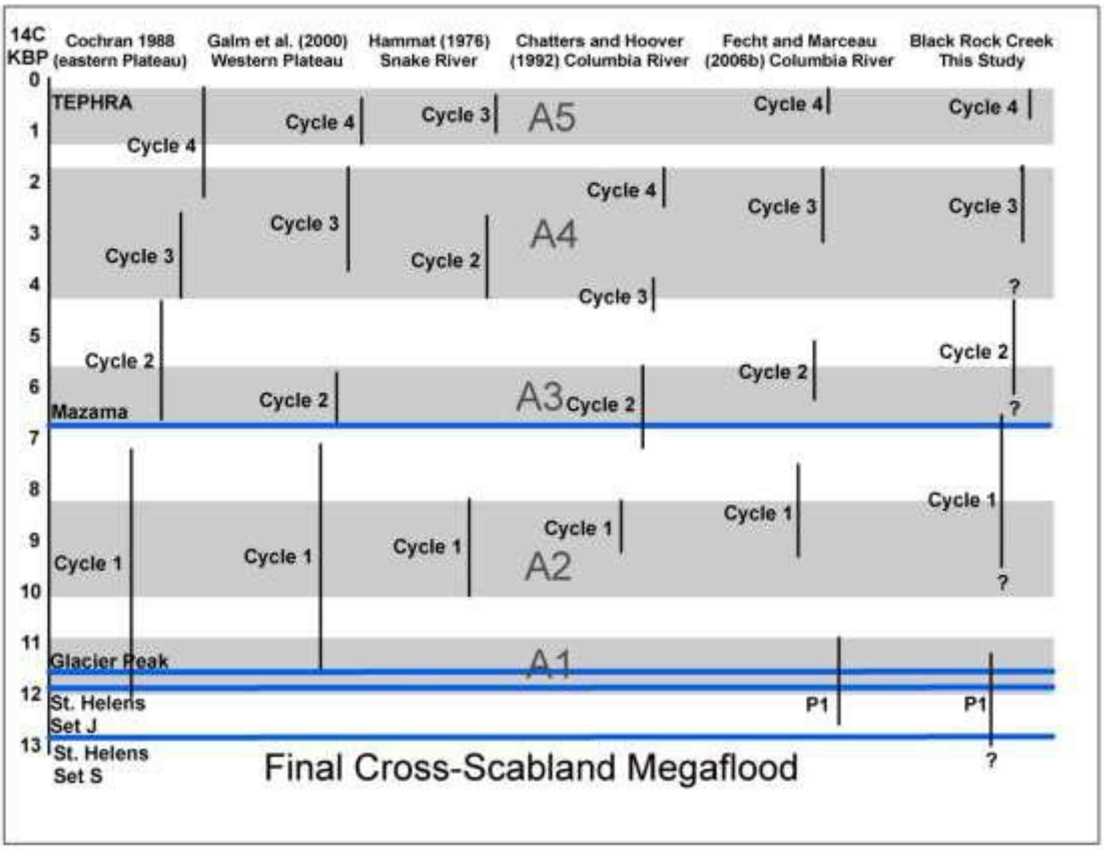


Figure 3.29 Correlation chart of alluvial cycles, Columbia Plateau. Horizontal gray bars refer to climate-induced periods of predominant aggradation.

In his analysis of the Palouse watershed, Huckleberry (2003) focuses on forager riparian resource availability throughout the Holocene. Along the Palouse River and four tributaries, riparian stability appears to be the norm and that Palouse region streams did not experience periods of downcutting that are common on other regional drainages. While the mainstream Columbia, Snake and other upland tributaries experienced punctuated aggradation and degradation cycles, resulting in terraced steps along their courses, the Palouse was a consistent riparian habitat. He suggests that if riparian resources were restricted along the major watercourses during this time of floodplain entrenchment, riparian resources would have remained abundant in the Palouse region.

Palouse drainages appear to be out of phase with the dominant alluvial cycles seen on the larger rivers (Columbia, Snake, Clearwater and Salmon). This is not surprising given loess vs. bedrock dominant watersheds and local base level controls (Huckleberry 2003). This does not preclude, however, some overlap in stream behavior that may be caused by major climate shifts (e.g., the shift to drier conditions during the early Holocene). For example, some of the channel cutting and filling (lateral accretion) seen on Palouse streams might correspond to early Holocene downcutting and terrace formation on the larger rivers. However, the former drainages have relatively narrow, confined floodplains that might not be conducive for preservation of terraces (personal communication, Huckleberry 2010). Similarly, pulses of overbank, vertical accretion during the late Holocene on the small Palouse streams may correspond to aggradation on the larger rivers.

In a relatively tectonically stable area like the Columbia Plateau, climate must drive fluvial dynamics; however, "noise" in the system is caused by differences in vegetation, bedrock lithology, basin hypsometry, and local bedrock controls. This will cause variability in the response of fluvial systems to any one climate change (and allow for greater ecological diversity in the landscape). The alluvial chronologies from different drainages across the region appear to compare well with each other. Contemporaneity in erosion/deposition despite differences in local geomorphic controls suggests that climate change has resulted in similar fluvial response across alluvial systems.

Reach-scale studies of alluvial deposition along the Middle Columbia and tributary drainages contribute to the development of an Upper Pleistocene/Holocene model of alluvial construction, which is applicable to dating archaeology of the Columbia Plateau. Catastrophic flood terraces flank the primary river trenches into which upper Pleistocene and earliest Holocene terrace are inset. While the terraces are extensive in places, they are not continuous throughout the Columbia Plateau (Chatters and Hoover, 1986, 1992; Huckleberry et al., 1998). A significant amount of fieldwork has concentrated on the age of the A2 terrace as a result of recent studies at the Kennewick Man site (Huckleberry et al., 1998; Huckleberry and Stein, 1999). Generally, the initiations of the A1-A2 aggradations are dated between 12 and 7 KBP. Later Holocene terrace steps are preserved solely within the Hanford Reach, central Washington, where they are not inundated by reservoir impoundment.

Far and away, the highest concentration of archaeological sites is found on the Holocene river terraces. Because of extensive efforts to dam the mainstream Columbia and Snake Rivers for hydroelectric power generation, the Holocene terraces have also had more archaeological reconnaissance than any other regional landforms. The Kennewick Man eroded from early Holocene alluvial sediments in the McNary Reservoir, a hydroelectric impoundment.

Table 3.5 displays radiocarbon dates associated with the alluvial chronology. Post Wisconsin alluvial stratigraphy of the mainstream Columbia River drainage developed by alternating cycles of alluvial deposition and landform stability. Holocene aggradation episodes followed closely behind the Upper-most Pleistocene catastrophic (glacial Lake and sub-glacial) floods dated in this study to 12.8 KBP. Initiation of a multiple Holocene fine-grained terrace system commenced prior to 9 KBPand continued through to approximately .5 KBP. A comparison of stratigraphic sequences reveals that (1) extensive tracts of early Holocene floodplain are preserved along the mainstream Columbia River; (2) there is little variability in the age and character of the early Holocene terrace deposits; (3) sedimentologic and pedologic details of the early Holocene terraces are readily differentiated from later Holocene terraces; (4) early Holocene archaeological sites are commonly buried within the former floodplain, the full suite of Colonizer period archaeology should be anticipated on the higher terraces (Figure 3.30).

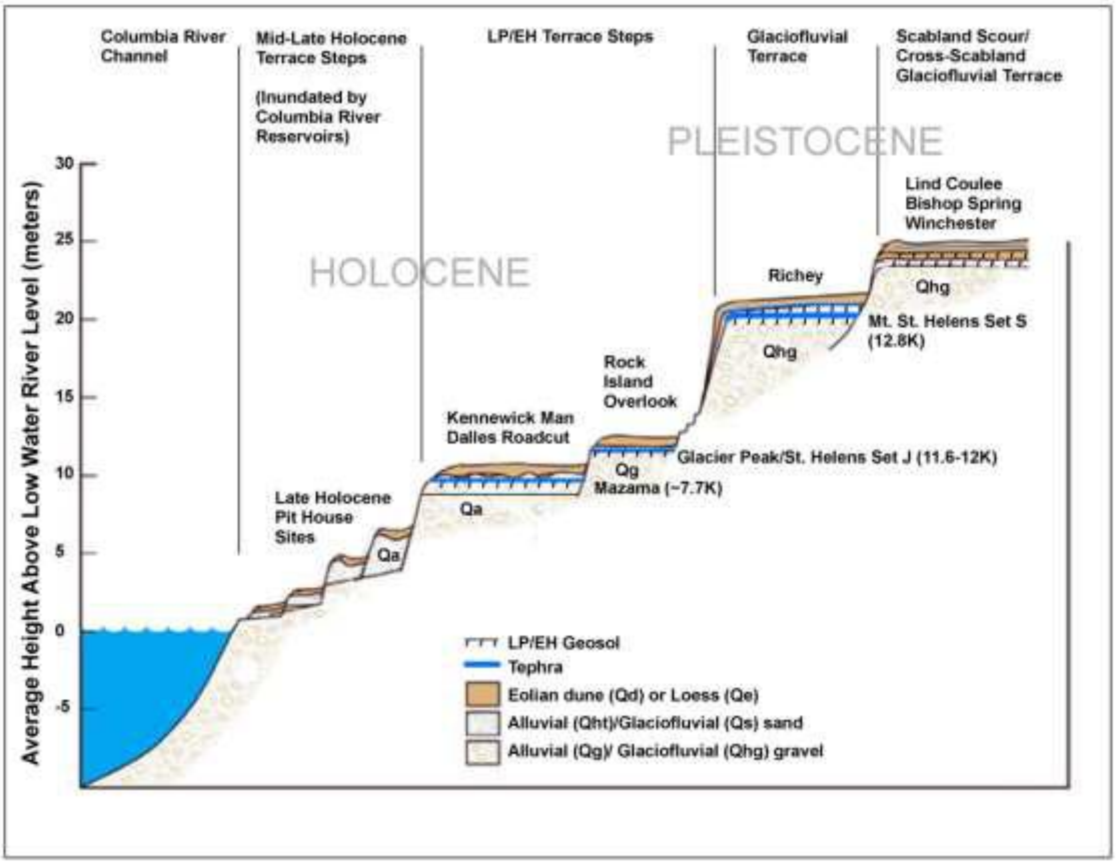


Figure 3.30 Archaeological Relationship to Alluvial Terrace Sequence

## Tephrochronology

Tephrochronology the study of airborne volcanic ejecta, can be applied to Quaternary geologic sequences, greatly aiding archaeological and geoarchaeological interpretation. On the Columbia Plateau tephrochronology is a fundamental tool that is used in understanding terrestrial sequence stratigraphy, although its reliability as a precise chronometric tool is dependent on critical analysis of site-specific depositional and post-depositional factors (Table 3.6). Without overstating its relative limitations, it is

Table 3.5 Radiocarbon Dates Associated with Alluvial Chronology

| C 14 Age | δ13C | Date BP | Material | Description | Source |
|---|---|---|---|---|---|
| 6120 ± 40 AMS | -24.5 $^{o}/oo$ | 7028-6936 | Total humates | In A2 terrace sediments, -200-210cm | This Study (Beta 282908) |
| 7010 ±160 | N/A | 7968-7684 | Total humates | 1.5 m below surface, Total humates at top of alluvial plug in ancient channelway, 2 cm below Mazama | Fecht and Marceau 2006 (GX-31656) |
| 7090 ±130 | N/A | 8025-7783 | Shell | 69 cm below surface of H3 Terrace, eolian sand atop overbank alluvium | Fecht and Marceau 2006 (GX-26215) |
| 7330 ±110 | N/A | 8212-8018 | Shell | 46 cm below surface of H3 Terrace, overbank alluvium | Fecht and Marceau 2006 (GX-26056) |
| 7710 ±340 | N/A | 8987-8277 | Shell | In blowout surface of H3 Terrace, atop overbank alluvium | Fecht and Marceau 2006 (GX-26065) |
| 7880 ±110 | N/A | 8792-8583 | Shell | 1.18 to 1.27 m below surface of H4 or H3 Terrace, overbank alluvium | Chatters and Hoover 1992 (UCR3476) |
| 7960 ± 210 | N/A | 9035-8546 | Shell | 25 cm below surface of H3 Terrace, overbank alluvium (projected below Mazama tephra) | Fecht and Marceau 2006 (GX-26159) |
| 8130 ± 40 | N/A | 9092-9011 | Bone collagen | H3 Terrace, overbank alluvium | Taylor et al. 1998 (CAMS-29578) |
| 8270 ± 100 | N/A | 9335-9130 | Shell | 1.00 m below construction modified surface of H3 Terrace, eolian sand | Marceau and Sharpe 2006 (GX-32054) |
| 8410 ± 60 | N/A | 9501-9402 | Bone collagen | H3 Terrace, overbank alluvium | Taylor et al. 1998 (CAMS-29578) |
| 8410 ± 40 | N/A | 9490-9418 | Bone collagen | H3 Terrace, overbank alluvium | Taylor et al, 1998 (CAMS-29579) |
| 8650 ± 110 | N/A | 9780-9524 | Shell | 60 to 70 cm below surface of H3 Terrace, eolian sand | Fecht and Marceau 2006 (GX-31300) |
| 8860 ± 80 | N/A | 10159-9887 | Shell | 80 to 90 cm below surface of H3 Terrace, overbank alluvium | Marceau and Sharpe 2006, 2002 (GX29272) |
| 9010 ± 50 | N/A | 10237-10169 | Total humates | 20 cm below surface of H3 Terrace, overbank alluvium | Wakeley et al. 1998 (WW1626) |
| 9360 ± 60 | N/A | 10666-10509 | Total humates | 1.00 m below construction modified surface of H3 Terrace, eolian sand | Marceau and Sharpe 2006 (GX320055)AMS |
| 10350 ± 60 AMS | -22.8 $^{o}/oo$ | 12223-12081 | Total humates | A2 terrace, Wanapum reservoir | This study; Beta (277407) |
| 12460 ± 50 | N/A | 14747-14235 | Total humates | ~2.25 m below surface of H3 Terrace, overbank alluvium | Wakeley et al. 1998 (WW1737) |
| 12790 ± 90 | N/A | 15283-14991 | Total humates | 2.00 m below surface In alluvial sand plug overlying fluvial gravel | Fecht and Marceau 2006 (GX31657) AMS |
| 14560 ± 50 | N/A | 17883-17611 | Total humates | ~3.20 m below surface of H3 Terrace, overbank alluvium | Wakeley et al. 1998 (WW1738) |
| 15330 ± 60 | N/A | 18661-18548 | Total humates | ~3.05 m below surface of H3 Terrace, overbank alluvium | Wakeley et al. 1998 (WW1627) |

important to understand these restrictions and to consider the scope and scale of applied tephrochronology. In loess sequences of the Palouse formation in southeastern Washington State, Busacca et al. (1992) presented tephrochronology as a time-stratigraphic tool to correlate sediments in diverse loess environments, over long distances. In most cases, particularly within the Holocene time-scale, where precise control is required, tephrochronology should be considered a rock-stratigraphic application, given the vast potential for eolian and alluvial re-deposition of surface sediments. Volcanic tephras are most commonly preserved in local depositional basins or in alluvial sequences where they are almost never in primary depositional position.

Given this caveat, within the context of the present study, the application of volcanic tephrochronology to archaeological research across the Columbia Plateau has aided in development of precise relative archaeological sequences even prior to modern radiocarbon dating techniques (Lyman 2000). The culture history of the region was built on a geochronologic foundation that has endured with only occasional adjustments as applied radiocarbon analyses provide greater temporal resolution.

The Cascade arc contains a number of strato-volcanoes which have a complex and destructive history of eruption that spans the Pleistocene period. Volcanoes of the Cascade arc are a product of subduction of the Juan de Fuca and Gorda continental plates, which collide with the North American plate, directed obliquely from the southwest towards the northeast (Figure 3.31). As the plates collide, the underlying (hot) plates continue to subduct until they reach sufficient temperature and pressure to melt. Ongoing subduction continues to feed the magma chambers which ultimately build pressure and periodically erupt, sending volcanic ejecta, pyroclastic and lahar flows and tephra onto Earth’s surface. The Cascade volcanoes range from northern California to southern British Columbia. Mount Mazama was one of the major Cascade volcanoes before its collapse formed the Crater Lake caldera.

**Mt. St. Helens**

Mullineaux (1986) provides the most comprehensive characterization of the eruptive sequence of Mt. St. Helens. The history of the volcano is divided into two eruptive segments termed “Old” and “Modern”. The “Old” segment, referring to the period of time prior to 2.5 KBP, was differentiated by Verhoogen (1937) based on its mineral composition; it was silicic, erupting dacites and andesites. The “Modern” volcano, which has much higher mafic mineral content, erupts olivine basalts to andesites and dacites (Mullineaux and Crandall, 1981). Both volcanic phases have produced abundant tephra, pyroclastic-flow deposits, domes, and short lava flows. These two eruptive segments include four eruptive stages over the past 40,000 years, beginning

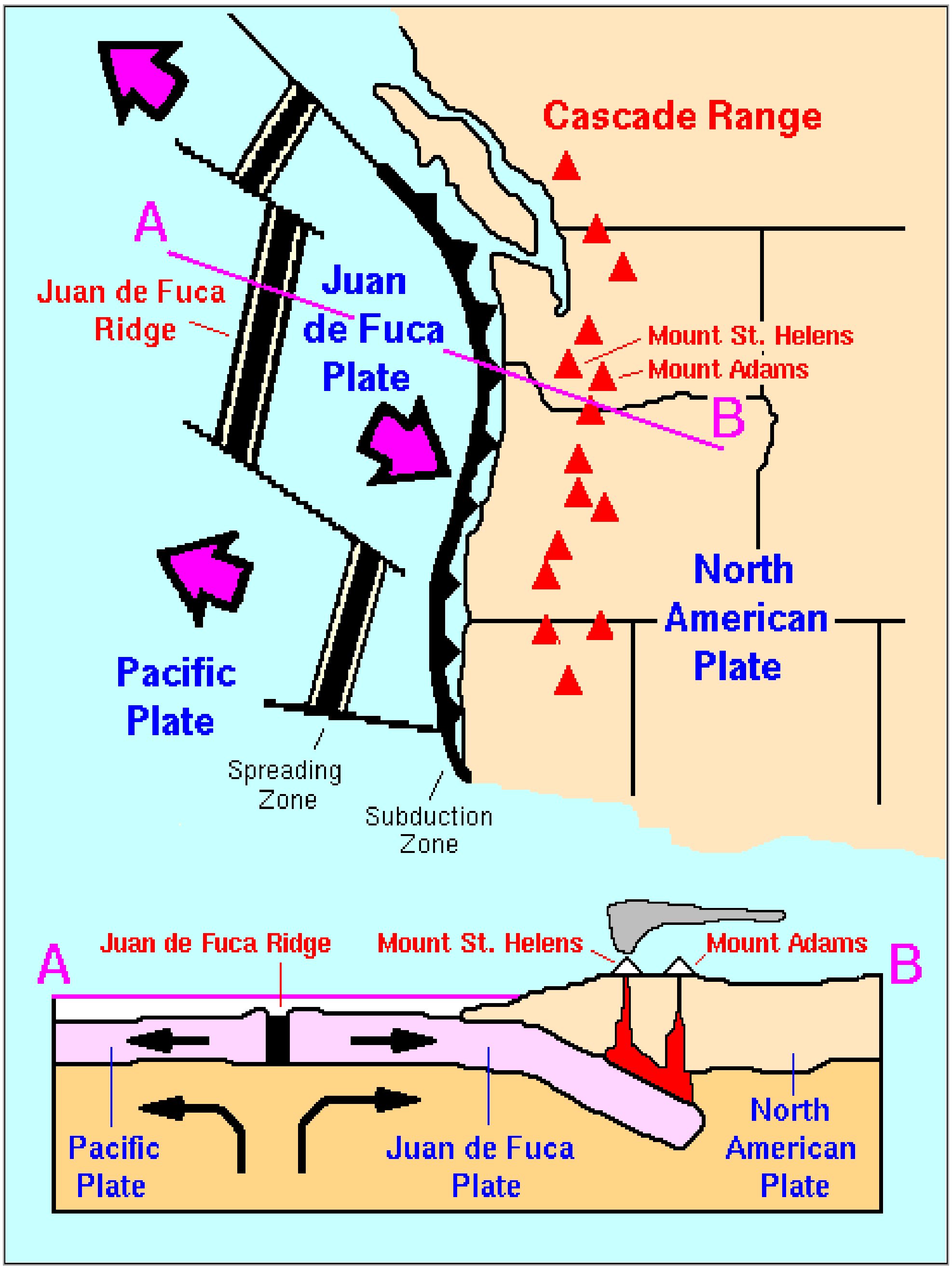


Figure 3.31 Volcanoes of the Cascade Range with subducting continental plate relationships. Courtesy of the North Cascades Volcano Observatory.

with the "Ape Canyon Stage" (40-35 KBP), the "Cougar Stage" (20-18 KBP), the "Swift Creek Stage" (13-8 KBP) and the "Spirit Lake Stage" since 2.5 KBP. Of these, the Swift Creek and Spirit Lake stages are most applicable to interpreting regional archaeological sequences.

**Swift Creek Stage**

The Swift Creek stage includes two distinct episodes of tephra production, one about 12.8 KBP (Tephra Set S; see dating below) and the second between roughly 12 and 10.5 KBP (Set J). Both sets are characterized by a few large-volume dacitic pumice layers that consist chiefly of lapilli near the volcano and fine (silt) layers up to hundreds of kilometers to the east of the volcano. In terms of application to Colonizer archaeology, the Set S and Set J tephras are the most important Mt. St. Helens tephras.

**Tephra Set S**

Tephra Set S was erupted about 12.8 KBP during the early part of the Swift Creek stage (Figure 3.32). The Set S tephra occurs across depositional environments, including loess, colluvium and at the cap of megaflood deposits across the Columbia Plateau. It is usually present as a couplet ash, in megaflood slackwater sediments it is deposited at the surface of consecutive floods, never separated by them. The age of Set S tephra is known by its relationship to the radiocarbon dated remains of a specimen of Ovis Canadensis catclawensis (Pleistocene Mountain sheep) discovered between two Set S tephras near the Wanapum Dam, central Washington State (Figure 3.12). The stratigraphic situation of the Set S tephra suggests that the eruption sequence was coincident with the final stages of cross-scabland flooding in the Columbia Plateau. The stratigraphic section that Mullineaux et al. (1978) utilized for their correlation to the St. Helens Set S tephra is less than 300m from the Mountain sheep site.

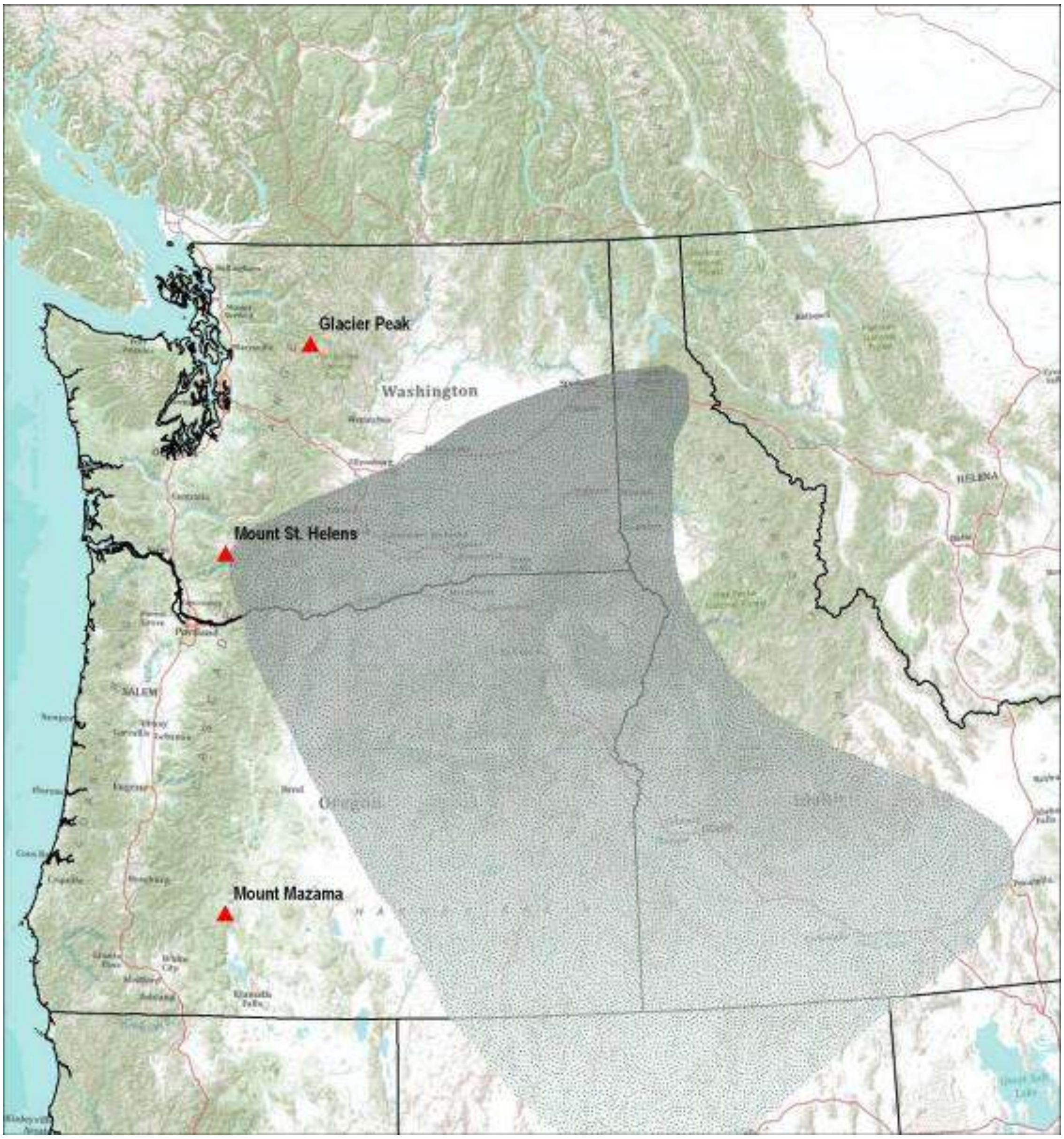

Figure 3.32 Distribution of Mt. St. Helens Set S tephra, 12,800±60 (CAMS 59589)

Diagnostic characteristics of Mt. St. Helens Set S include: 1) The presence of multiple tephra layers in close proximity to each other (often present as a couplet or triplet); 2) Very fine textural size; and 3) Association with late Pleistocene glaciofluvial sediments in the river valleys and across the Scablands.

**Tephra Set J**

Tephra Set J was erupted between about 12 and 10.5 KBP during the late part of the Swift Creek stage (Figure 3.33). The set is characterized by a few large-volume dacitic pumice layers that consist chiefly of lapilli near the volcano. Layers have been recognized hundreds of kilometers east of Mount St. Helens. Diagnostic characteristics of Mt. St. Helens Set J include: 1) The presence of a couplet with

Figure 3.33 Distribution of Mt. St. Helens Set J Tephra

Glacier Peak tephra with the tephra layers in close proximity to each other; 2) Very fine-grain size; and 3) Association with late Pleistocene glaciofluvial sediments in the river valleys and across the Scablands.

**Glacier Peak**

Porter (1978) and Beget (1981, 1984) discussed the eruptive history of Glacier Peak. Located in the North Cascades, Glacier Peak, like Mt. St. Helens, provides tremendous potential for understanding details of late Quaternary sedimentary sequences and archaeological site details. The Glacier Peak tephra occurs across depositional environments, including alluvium, loess and colluvium, overlying megaflood deposits across the Columbia Plateau (Figure 3.34). It is often present as a couplet ash with Mt. St. Helens Set J tephra, or as a triplet with the same ash. Fecht and Marceau (2006b) report that the couplet is observed in over bank deposits of Cold Creek Valley, apparently in a similar stratigraphic situation as the T3 terrace of the Black Rock Valley (alluvial section above). The same authors also report that Glacier Peak is present in thin loess sheets that occur between underlying glaciofluvial flood gravels and overlying sand dune colonies along the Hanford Reach. Glacier Peak tephra post-dates large-scale cataclysmic flooding in the river valley and is known from smaller ice-dam floods that were restricted to the Columbia River valley (Gough 1995; Waitt 1984).

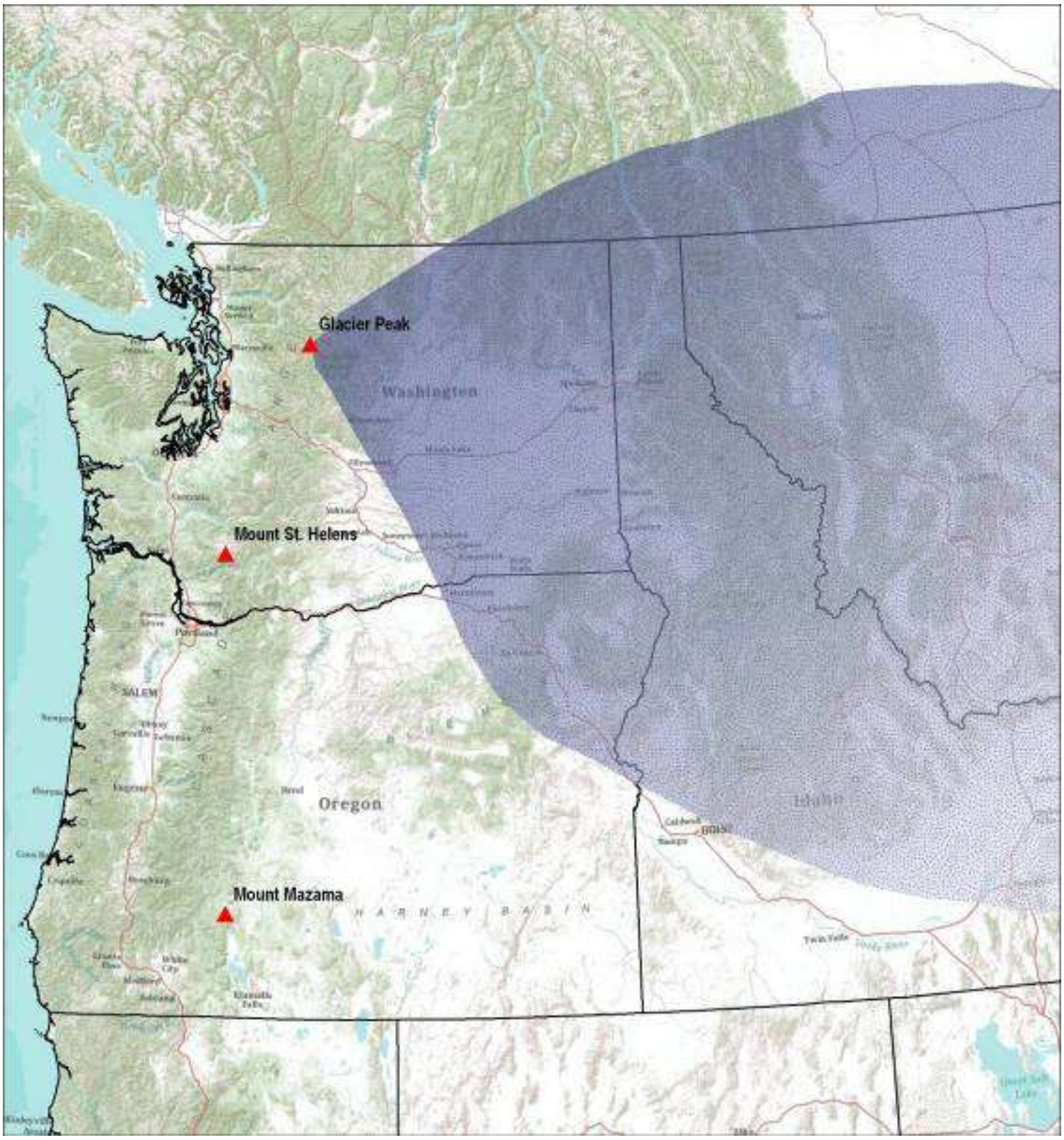


Figure 3.34 Distribution of Glacier Peak Tephra

Stan Gough and I made a fieldtrip to an exposure of Glacier Peak tephra at an alluvial cut near Chelan Falls, Washington, less than 20 km from the source vent at Glacier Peak. By stratigraphic correlation, Gough (1995) determined that the tephra is Glacier Peak layer "G" tephra, the earlier of two upper-most Pleistocene eruptions, dating to ~11.6 KBP (Kuehn et al. 2009). The tephra at the site is immediately underlain (in stratigraphic contact) by alluvially-placed charcoal that likely resulted from a brush fire directly upstream. The site locale is a strong candidate to aid in understanding timing of Glacier Peak layer "G" emplacement due to the presence of abundant burned plant macrofossil remains. We sampled the charcoal lens and Stan Gough extracted from it numerous fragments of very small twigs and stems. Results of the radiocarbon analysis by Stafford Research Labs indicate that the tephra was deposited soon after 12,800±60 years ago (CAMS 59589).

**Mt. Mazama**

Throughout the Pacific Northwest region the close of the early portion of the Holocene period is marked by volcanic tephra from the climactic eruption of Mt. Mazama (Crater Lake, Oregon; Figure 35). Mazama tephra is ubiquitous to Columbia Plateau sediment sequences. Due to its sheer volume, unlike the other tephras, it is found in all depositonal settings, alluvial systems and in upland sequences. Zdanowicz et al. (1999) converted Bacon's (1983) eruption age of 6.9 KBP to calendar years, with a resulting calendrical age range of 7545 to 7711 cal yr (Table 3.6).

**Field Characteristics of Pacific Northwest Volcanic Tephra**

Volcanic tephra are expressed in the field as thin horizons (between 2-20 cm.) with significant contrast to their bounding sediments. Tephra colors range from white to gray, depending on the degree of mixture, post-depositional alteration with bounding deposits or pedogenic transformation. Distal volcanic tephras that occur in typical field settings are fine-grained, ranging from fine silt to granules, depending on the distance travelled from their source vent. Tephra is only rarely exposed as a direct air fall horizon; it is generally mixed by post-depositional processes.

Fecht and Marceau (2006b) described characteristics used to distinguish volcanic tephras in the field, including horizon thickness, color, texture, spatial relationships between tephra horizons and the stratigraphic context (Table 3.6). Glacier Peak is recognized by multiple eruptive events (couplet), and the ash commonly has a gritty texture. Mazama is the youngest of the three tephras and is commonly thicker than the other two volcanic ashes (greater than 20 cm in thickness). Mazama ash often displays color variations with the upper portion white (7.5YRN8 to 10YR8/1) to light gray (10YR7/1 to 10YR7/2), and a lower portion having a pinkish (5YR8/3 to 5YR8/4) hue. On the west side of the Cascades the Mazama tephra often has an orange hue due to pedogenic alteration by low-base-cycling plants (Lenz and Gentry 2010).

**Discussion**

Pleistocene-age landforms, where these early sites are located, are common across Washington State and are generally related to glacial, glacio-fluvial or alluvial depositional processes. Along the coast, sea-level rise has inundated the continental shelf—arguably the environment with highest potential to hold the archaeological record of the initial colonizers of Washington state. The glaciated interior of the Puget Lowland has, since the close of the ice-age, undergone isostatic rebound, and the upper Pleistocene environments are in many places more than one hundred meters above and often miles inland from the modern coastal environment. Coast-proximal alluvial valleys in the Puget Lowland have undergone similar isostasy and stream-side archaeological sites are now located on high terraces above the modern waterways. To the interior of the state, the late-glacial megafloods carved giant channels into the former loess-covered landscape, leaving an interconnected system of "coulees" which early people used as transportation corridors. In many places these coulee drainage

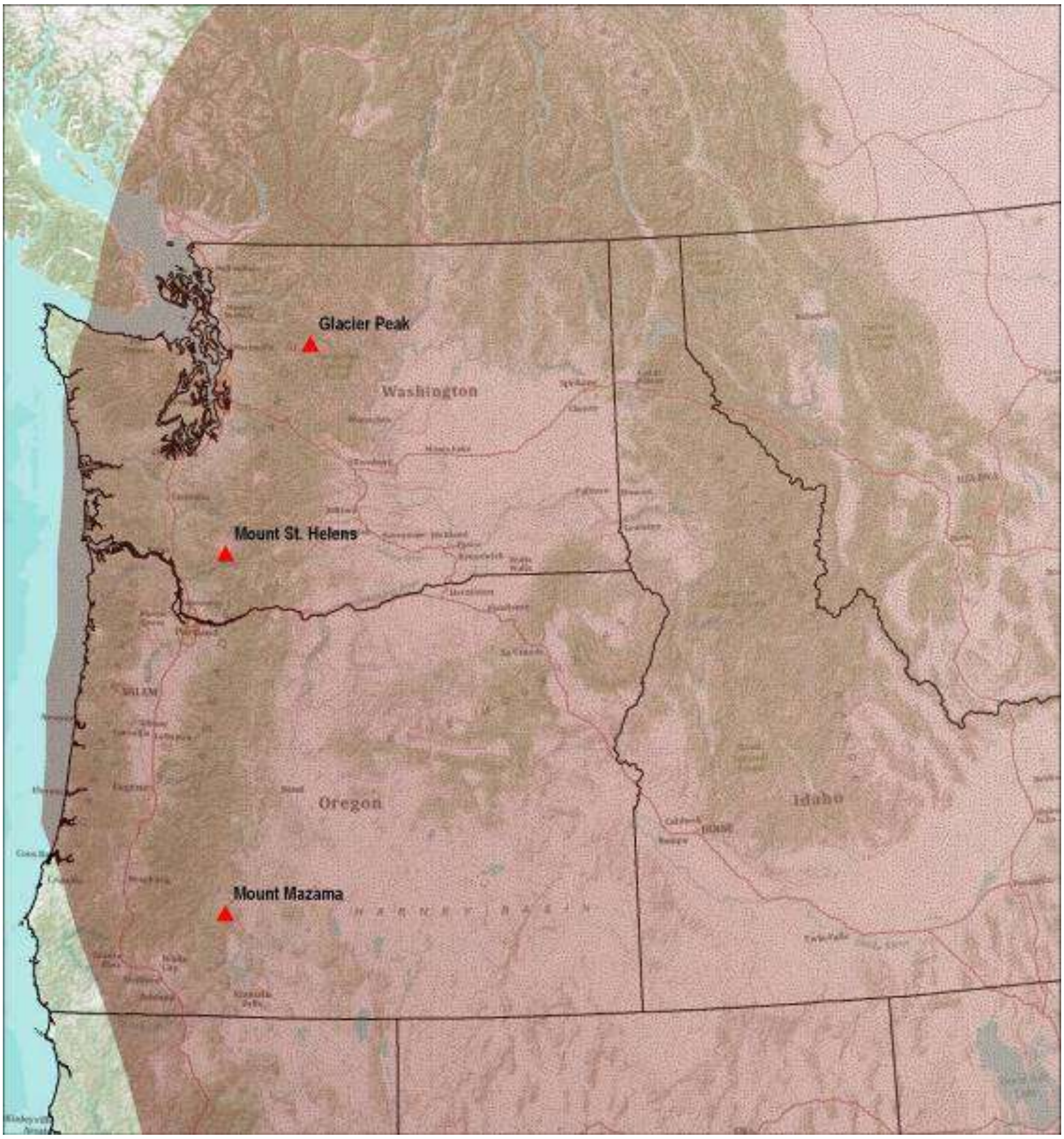

Figure 3.35 Distribution of Mazama Tephra (total coverage)

systems formed into a patchwork mosaic of resource-rich wetlands in the uplands away from the primary river valleys. The river corridors and their tributary systems hold a record of upper-Pleistocene to early Holocene alluvial deposition that, in terms of volume of deposition, eclipses subsequent valley fill events.

Table 3.6 Field Characteristics of Pacific Northwest Volcanic Tephras (after Fecht and Marceau 2006b)

| **Tephra** | **Color** | **Eruptive Events** | **Thickness** | **Grain Size** |
|---|---|---|---|---|
| Mount St. Helens Set J | White (7.5 YRN8 to 10YR8/1) to | 1 | Mainly 3 mm to 6 mm, locally | Sandy silt to silty very fine sand |
| May 18, 1980 | light gray (10YR7/1 to 10YR7/2) | 1 | accumulates in gullies (maximum observed 15 cm) | |
| Mazama | White (7.5YRN8 to 10YR8/1) to pink (5YR8/3 to 5YR8/4); pink is commonly in lower part of horizon | 1 | Commonly 15 to 20 cm, locally accumulates in topographic lows (up to 1 m) | Silt |
| Glacier Peak | White (7.5YRN8 to 10YR8/1) | 2 | Upper 25 mm to 50 mm; lower 12 mm to 50 mm | Sandy silt to silty very fine sand |
| Mount St. Helens Set S | White (7.5YRN8 to 10YR8/1) | Mainly 2 in central/ southern Columbia Basin (rarelymore); mainly 3 in northern Columbia Basin (occasionally more) | Couplet: upper 25 mm to 50 mm (locally up to 15 cm in glaciofluvial channels); lower 6 mm to 12 mm; other units 3mm to 12 mm | Silt to sandy silt |

# CHAPTER 4
# PALEOPEDOLOGY

## Introduction

Chapter 3 introduced the overall geologic and geomorphic setting of the region. The goal of this chapter is to establish a soils-stratigraphic context that may be applied across the majority of regional sedimentary depositional environments in the Pacific Northwest. Ferring (1994) identifies some region-scale objectives for geoarchaeological research relating specifically to Paleoindian studies such as this, including 1. The delineation of site associations with extensive (mappable) geomorphic features or stratigraphic units; 2. Definition of region-scale past environments; 3. Use of geologic data to develop strategies for site detection and settlement pattern analysis. The identification of significant additions to the regional stratigraphic framework, which is the core of this chapter, once tied to Colonizer period sites, meets these goals directly.

The value to this approach was initially considered by Butzer (1982:43) who discussed the establishment of landscape contexts of archaeological sites. He identified several modes of landscape context across a range of scales; small-scale research is identified as the site microenvironment, that area whose specific characteristics were selected for use by prehistoric people. Medium scale research is related to definition of regional environmental landscapes, which are used to evaluate site-selection and subsistence patterning. Large scale context is related to regional macroenvironments of which the medium-scale environmental matrices are its constituent parts. The establishment of a region-wide pedologic framework is part of the large-scale context, as soils signatures are present in a relatively uniform way from the maritime coast to the arid interior deserts of the Pacific Northwest region. The focus in this aspect of the study is to consider large-scale landscape or *soilscape* aspects that may assist researchers in identifying buried archaeology that dates to the Colonizer period.

Lyman (2000) pointed out that archaeology in the Pacific Northwest, and in eastern Washington state in particular, has long benefitted from the application of relative geochronologic control, even prior to the vastly improved resolution that radiocarbon dating provided. Utilizing simple principles of stratigraphic relationships to the archaeological material, the culture history of the region was created via geoarchaeological methods. The development of radiocarbon dating only served to provide relatively small adjustments to the culture historic framework. The chronology was established via diverse data, including tephrochronology, sediment marker beds (ie. megaflood sediment or glacial deposits which pre-date known archaeology), and discontinuous artifact seriation sets. The present study identifies a record of buried, ancient soils that are present throughout the region. With the benefit of high-resolution radiocarbon data applied to understand the age of the buried soils, as time-stratigraphic markers they are as reliable as any of the above methods in their ability to help sort out relative age of archaeological sites. More than that, by understanding pedogenic details of the soil sequence it is possible to reconstruct archaeological site use histories in ways that the former tools are not able. The paleopedology of the Pacific Northwest region is rich, and until now is a relatively untapped source of chronologic control to assist in the discovery of early archaeological material.

An initial goal of this study was to identify characteristics of the Colonizer landscape of the Pacific Northwest region that would lend themselves to the detection of Colonizer period archaeological sites. In the process of searching for time-stratigraphic markers that would facilitate the identification of Colonizer-age landscapes, a series of geosols were identified and are described below. The purpose of this chapter is to define, for the first time, buried soils of the Pacific Northwest region; here termed the Bishop, Badger Mountain and Willow Lake geosols. Except for presentation at professional meetings and publication of associated abstracts over the course of the past few years, these regional soils are presently unknown in the archaeological literature.

**Role of soils in the identification of upper Pleistocene archaeological sites**

Prehistoric cultural landscapes occur at the scale of entire landforms (Butzer 1982). Where buried time-stratigraphic markers such as volcanic ash or clean, mineral (megaflood or glacially-deposited) sands are important to help determine the relative age of a given research locale, buried soils, or paleosols, represent former ground surfaces that were stable for a significant duration, so that they developed highly recognizable soil properties (Mandel and Bettis, 2001; Holliday, 2004). Because the buried stratigraphic horizons which paleosols represent were exposed at the surface for a relatively long period of time, they have the highest probability for containing buried and preserved archaeological sites. When these buried paleosols are recorded across a variety of depositional environments, they are termed geosols.

In the Pacific Northwest, climate change since the close of the Pleistocene period has driven episodic depositional events (dependent on the environment of deposition) followed by relatively long periods of landform stability. During the course of three relatively broad periods of depositional hiatus, soils formed across Washington State (cf. Fryxell and Cook 1964; this study). These soils, hereinafter referred to as geosols, are now buried, and archaeological material is commonly found in association with the former land surfaces. The discovery of buried archaeological sites is made possible, in part, by our ability to identify these region-scale buried geosol surfaces as, by definition, they are present in all depositional environments.

Two of the geosols straddle the Pleistocene/Holocene boundary and are therefore highly valuable in identifying archaeology of the upper Pleistocene period. The third, a buried middle to late-Holocene soil was identified by Roald Fryxell in 1964 but he did not explicitly or formally define the soil. While this latter geosol dates to a period long after the direct focus of this research, it is equally important as an indicator of time as its presence rules out the possibility of identifying upper Pleistocene or earliest Holocene archaeological sites.

The earliest soil, termed the Bishop geosol, dates to the Colonizer period, loosely defined as the period of initial occupation of the region, prior to the Holocene, and therefore has the highest probability for containing buried, preserved colonizer-period archaeological sites. A second soil, the Badger Mountain geosol, dates between the Younger Dryas period to the eruption of Mt. Mazama (~7.7 KBP)—the very late Paleoindian timeframe—and therefore has the highest probability for containing early Holocene archaeological sites. The third, the Willow Lake Geosol is a middle to late

Holocene soil that is commonly observed in the arid interior of the Columbia Plateau, but is often obscured west of the Cascade mountain range due to shallow sedimentary environments which make identification difficult due to effects of the plow or by welding onto earlier, relatively shallow soils.

Formal definition of the geosols is presented below, and known colonizer period sites are evaluated within the context of these early soils in Chapter 6. For characterization, I will utilize a sequence-stratigraphic approach for treatment of the regional pedostratigraphy (Miall 1997). This chronostratigraphic method is based on the identification of sediment surfaces which are known to represent time lines (e.g. subaerial unconformities formed by sedimentary depositional hiatus during a specific period of time). Whereas tephrochronology is a useful lithostratigraphic approach that is commonly applied across the region emphasizing similarity of the sediment lithology (Chapter 3), tephra are not consistently preserved in stratigraphic sequences, and they are subject to redeposition, which has potential to obscure the actual time represented by the tephra layer, and hence, to obscure archaeological interpretation. To the contrary, evidence for the regional geosols defined here is present across depositional environments (sedimentary rock units), and as a time-stratigraphic unit is therefore considered a primary indicator of archaeological unit age, especially in the absence of in situ tephra or other datable natural or cultural stratigraphic data.

**Definition of the term Geosol**

It is important here to define the use of terms, in particular, the difference between a paleosol and a geosol. While a paleosol may refer to any single, buried ancient soil, geosol refers to an assemblage of ancient soils and not to any single paleosol. A geosol is a "... soilscape that can be recognized as a laterally extensive stratigraphic horizon" (Retallack 1990, Follmer 1978, Morrison 1978). Morrison (1998) further defined the geosol concept, defining it as a buried catena (a lateral soil profile continuum) characterized by dominant soil types which are recognized and described in a stratigraphic context. In effect, a geosol is a fossil geomorphic surface (Retallack 1998). From a historic perspective, Morrison (1967) proposed the term geosol to replace the previous usage of the generalized term “soil”. Retallack (2001) suggested that the term “soil” has such varied meaning to the geologist, soil scientist, engineer and, farmer that is was inappropriate for this special use. Geosol is the formal term recommended for soil stratigraphic units in the most recent North American Stratigraphic Code, although until a geosol is adopted as a formal stratigraphic unit, it is appropriate to use the lower case form (North American Commission on Stratigraphic Nomenclature, 1983).

Birkeland (1984) proposed that geosols are restricted to buried soils and that they must be laterally traceable in the field, with known stratigraphic position. He also proposed that pedogenic environments may be variable, leading to lateral differentiation or soils facies. Not all paleosols are present at all locations as post-depositional factors may have led to truncation or complete erosion, however, geosols are laterally traceable, and in the Pacific Northwest, they are traceable from western Idaho to the Pacific Ocean.

**Establishment of Pedogenic Sequence Stratigraphy in Loess**

Localized buried soils of the Columbia Plateau are known from the literature going back nearly 50 years. Richmond and others (1965) identified a variety of loess deposits with buried paleosols spanning the period from pre-Wisconsin to the middle Holocene. They present late Wisconsin and Altithermal loesses overlying Channeled Scabland deposits (Figure 4.1). Fryxell and Cook (1964) also identified post-scabland (essentially Holocene) loess, and post-scabland loess was identified by Gentry (1974, 1984).

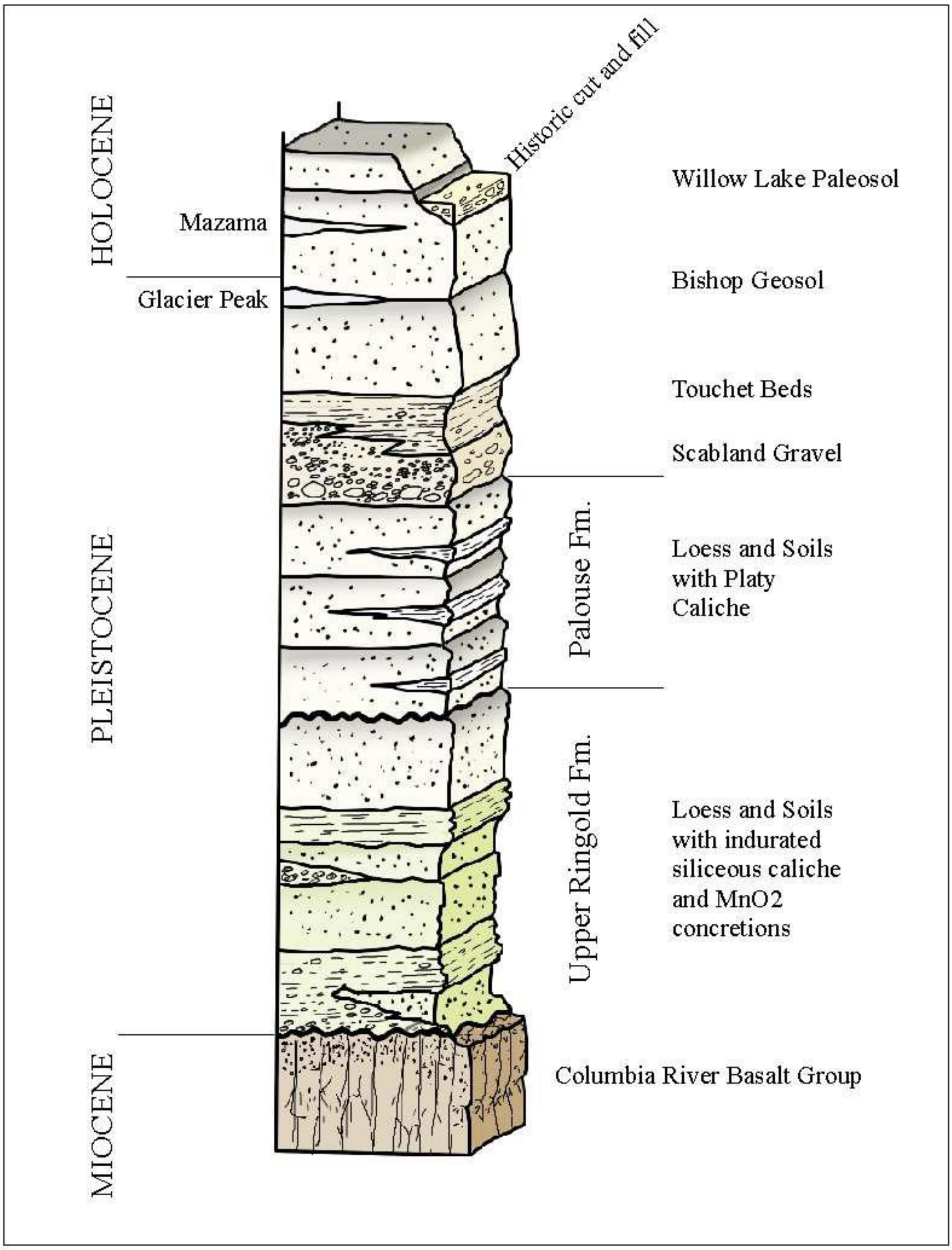


Figure 4.1 Graphic after Richmond et al. (1965) displaying location of upper Pleistocene soils in a stratigraphic column of loess. Willow Lake and Bishop geosols are presented as local pedogenic phenomena

Gentry's (1974) thesis included what he termed "weathering profiles" for multiple parent materials, measured variation in depositional thickness and traced changes from arid environments to moist environments in the eastern portion of the Columbia Plateau. Gentry distinguished the soils on the basis of the degree of a number of standardized variables, including pedogenic development, stratigraphic position, color, consistence, parent material and thickness. The importance of distinguishing specific characteristics of individual paleosols in this manner is a major factor in our ability to trace them laterally across a variety of depositional environments. In many locations, lithostratigraphic units such as volcanic tephra may bound buried paleosols, but not all locations have tephra preserved in place, which might otherwise allow rapid identification of individual paleosols. In these cases it is still possible to make a positive identification, utilizing Gentry's approach, based on independent variables defined specifically to distinguish the geosols one from the other. This method of identification has considerable geoarchaeological significance.

**Origin of Geosol Names and Basis for Type Transects**

Like geologic formations, geosols are named for specific "type" localities or areas. McDonald and Busacca (1992) utilized a "type transect" to define a series of local paleosols in the Palouse loess, due to lateral variation of their physical and chemical properties. This approach has merit in naming geosols, particularly given the nature of geosols as laterally continuous soils which cross sediment depositional settings. In order to capture the breadth of variation in each geosol, the Badger Mountain, Bishop and Willow Lake geosols are defined by identification of a type transect, or a small number of representative soil profiles in different but immediately adjacent depositional settings, rather than at one specific outcrop. The Bishop geosol is named for a series of exposures near the David Bishop ranch near Quincy, Washington, the Badger Mountain geosol is named for a series of exposures at the base of Badger Mountain near East Wenatchee, Washington and the Willow Lake geosol is named for two trenches at Willow Lake, near Soap Lake, Washington.

**Bishop, Badger Mountain and Willow Lake Geosols: Formal Definitions**

Overlying the regional surface geologic formations, the Ringold, and (informal) Hanford and Palouse formations in the central Columbia Plateau and the Kitsap formation to the west of the Cascade range, are a series of soils with strongly developed profiles. In order of stratigraphic situation (oldest to youngest) they are called the Bishop, Badger Mountain and Willow Lake geosols, after the David Bishop Ranch, the base of Badger Mountain near East Wenatchee and Willow Lake, near Ephrata, their type localities. The character of each soil is unique, as they represent a suite of soils that formed under significantly differing climatic conditions, and across a variety of depositional settings. Together, these soils are considered to mark the top of the upper Pleistocene deposits in the Pacific Northwest (Figure 4.1 and Figure 4.2).

McDonald and Busacca (1992) presented a series of pedostratigraphic units in the Channeled Scablands and the western Palouse, but they restricted their analysis to loess deposits. One of the soils they presented, the Sand Hills Coulee soil broadly dates to the age of the Badger Mountain geosol; but its proposed age crosses into the range of Bishop geosol presented here. Given the limited area and these considerations of time, the Sand Hills Coulee paleosol is here considered a local correlative soil to the Badger Mountain geosol.

Pedostratigraphy presented in this study builds on the work of Gentry (1974) incorporating aspects of the work presented in McDonald and Busacca (1992) and Busacca et. al (1992). I present a body of new data from non-loess environments


Figure 4.2 Known distribution of Pacific Northwest geosols

throughout the Columbia Plateau to the Pacific coast, as a sequence of regional geosols, informally presented over the past several years at geologic professional meetings (Lenz 2004; Lenz et. al 2002, 2007).

**Bishop Geosol**

*Narrative Overview*

The Bishop Geosol is a terminal Pleistocene age soil that is present from western Idaho to the Pacific coast. It is often characterized by a well-developed A horizon and relatively thin Cambic (Bw) or Argillic (Bt) horizons, depending on the environment of deposition. The age of this soil is constrained by its relative position surrounding Mt. St. Helens Set S (12.8 KBP) at its base and Glacier Peak tephra (11.6 KBP) at its cap.

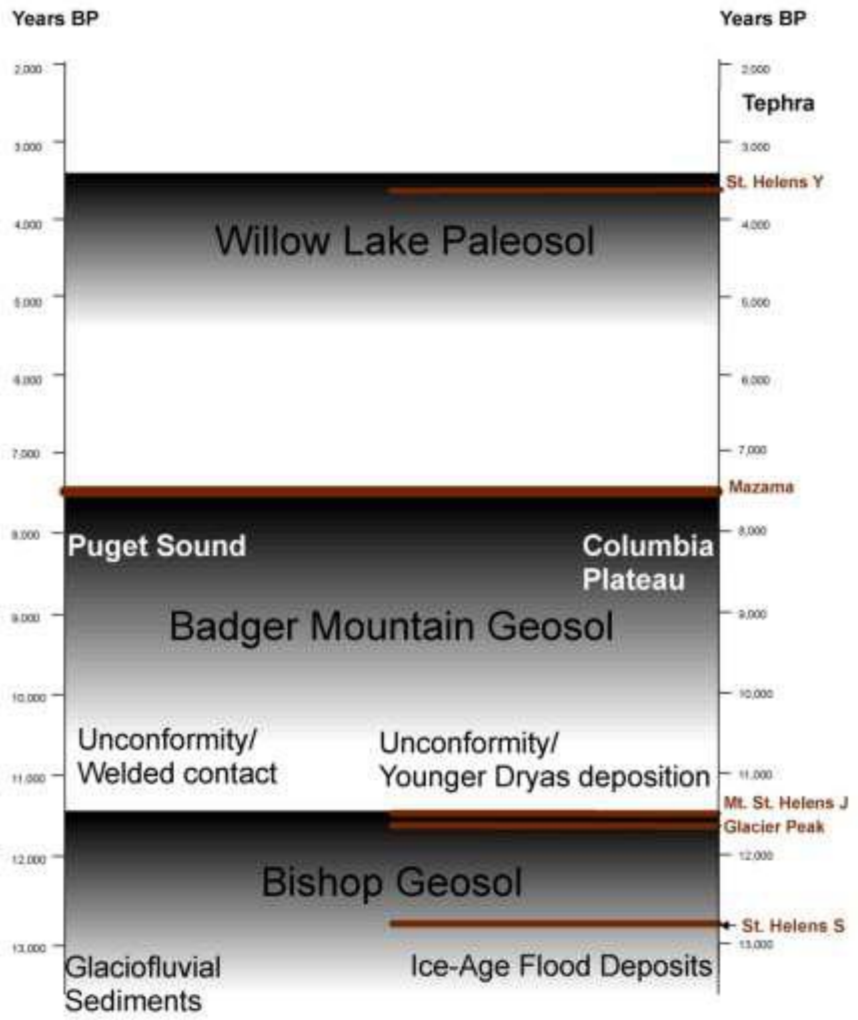


Figure 4.3 Pedostratigraphy of Regional Geosols

The upper-Pleistocene Rock Creek soil of Davis (2001) appears to correlate well with the Bishop Geosol, and several examples of Bishop-age soils that are recorded in the western portion of the Columbia Plateau, on the Yakima Firing Center also appear to correlate well, although due to the context of research the paleosols were identified within, they are treated as local pedogenic phenomena rather than regional-scale soils (Gough, Galm and Nials 2001:Figure 4.3).

The Bishop Geosol was first recognized at the David Bishop Ranch, on the Babcock Bench in Grant County, Washington (Lenz 2004). A dark Ab horizon has formed there at the contact of scoured basalt bedrock with the overlying, reworked megaflood sands parent material. On recognizing a buried soil horizon there, the author, with Herman Gentry, examined several central Washington roadcuts presented in previous studies by other Quaternary scientists in order to compare specific pedologic details, and to consider whether the individual soils might be part of a broader pedologic framework (Fryxell 1965, Moody 1978, Mullineaux et al. 1978). The subtle change in chroma that suggests soil formation is not often visible in weathered soil profiles of the arid interior Columbia Plateau, but once the faces of the roadcuts were freshly exposed by new excavation, it was possible to recognize characteristic Ab and Bw horizons that make up the soil. The relative stratigraphic position of the Bishop Geosol, generally forming into the cap of underlying C horizons of well-documented age, helped determine the relative age of the buried soils.

The significance of the Bishop geosol for early Paleoindian/Colonizer studies is extremely high. Timing of the geosol appears to coincide with the likely timing of initial colonization of the region. The partial remains of a sloth (Megalonyx Jeffersoni; 14C dated to 12.1 KBP) were discovered at one of the southernmost sections at the Bishop geosol type transect. At this location, a discontinuous reddish horizon sits between two megaflood rhythmites at a depth of 20 to 39 cm below the sloth tooth. Charcoal was identified at the lower boundary of the reddish horizon at one location and in root channels at other locations in the same trench. The reddish color appears to be the result of a burned organic horizon, indicating that the surface horizon was stable for enough time to accumulate enough fuel to burn the underlying organic-rich soil horizons. Similar data from Burlingame Canyon in south-central Washington State indicate that a channel with stratified alluvium was cut into megaflood deposits in the middle of the rhythmite sequence. Together, worm and root casts, burned organic horizons between flood events and channelization into flood deposits, suggest that significant time must have occurred between megaflood events. The Bishop geosol was clearly forming at this time, as it developed into the post-glacial megaflood deposits.

*Stratigraphic Relations and Occurrence*

The Bishop geosol is evenly distributed across the region (Figure 4.2). It is present across most depositional environments where sediment of upper-Pleistocene age exists, on both sides of the Cascade mountain range (Figure 4.4 and Figure 4.5). The Bishop geosol is generally more poorly expressed than the Badger Mountain geosol, but has stronger expression than the Willow Lake geosol. In terms of its application to Colonizer period archaeology, the Bishop geosol is one of the most useful stratigraphic markers for archaeological and geologic research. The Bishop geosol is sometimes evident on relict exposures of an older, un-named Pleistocene paleosol but it is masked by the stronger development of the older soil. The Badger Mountain geosol is often welded onto the Bishop geosol, especially in shallow depositional environments and in distal L1 loess deposits of the Columbia Plateau.

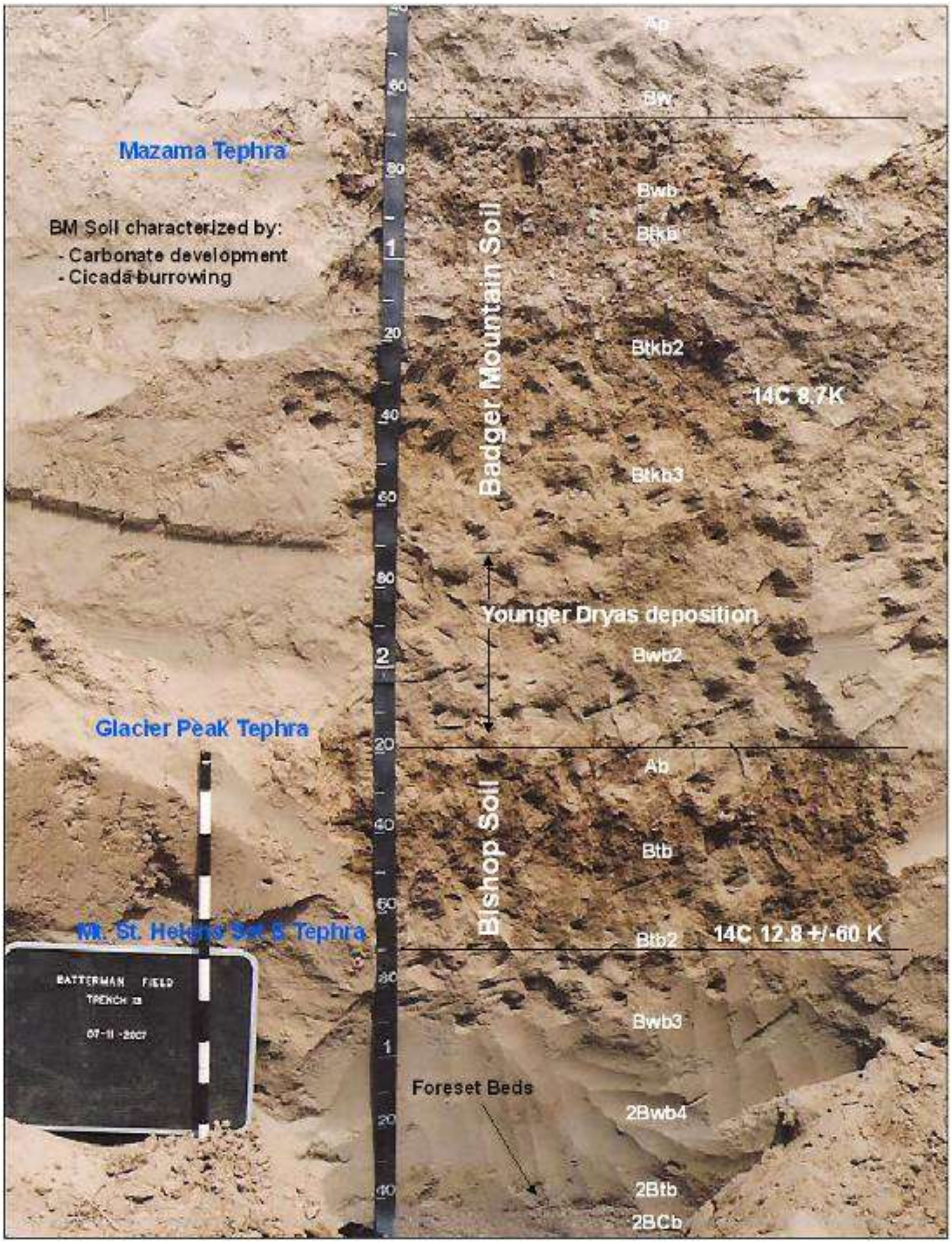


Figure 4.4 Typical exposure of the relationship between the Bishop and Badger Mountain geosols in the arid portion of the Columbia Plateau east of the Cascade Mountain range.

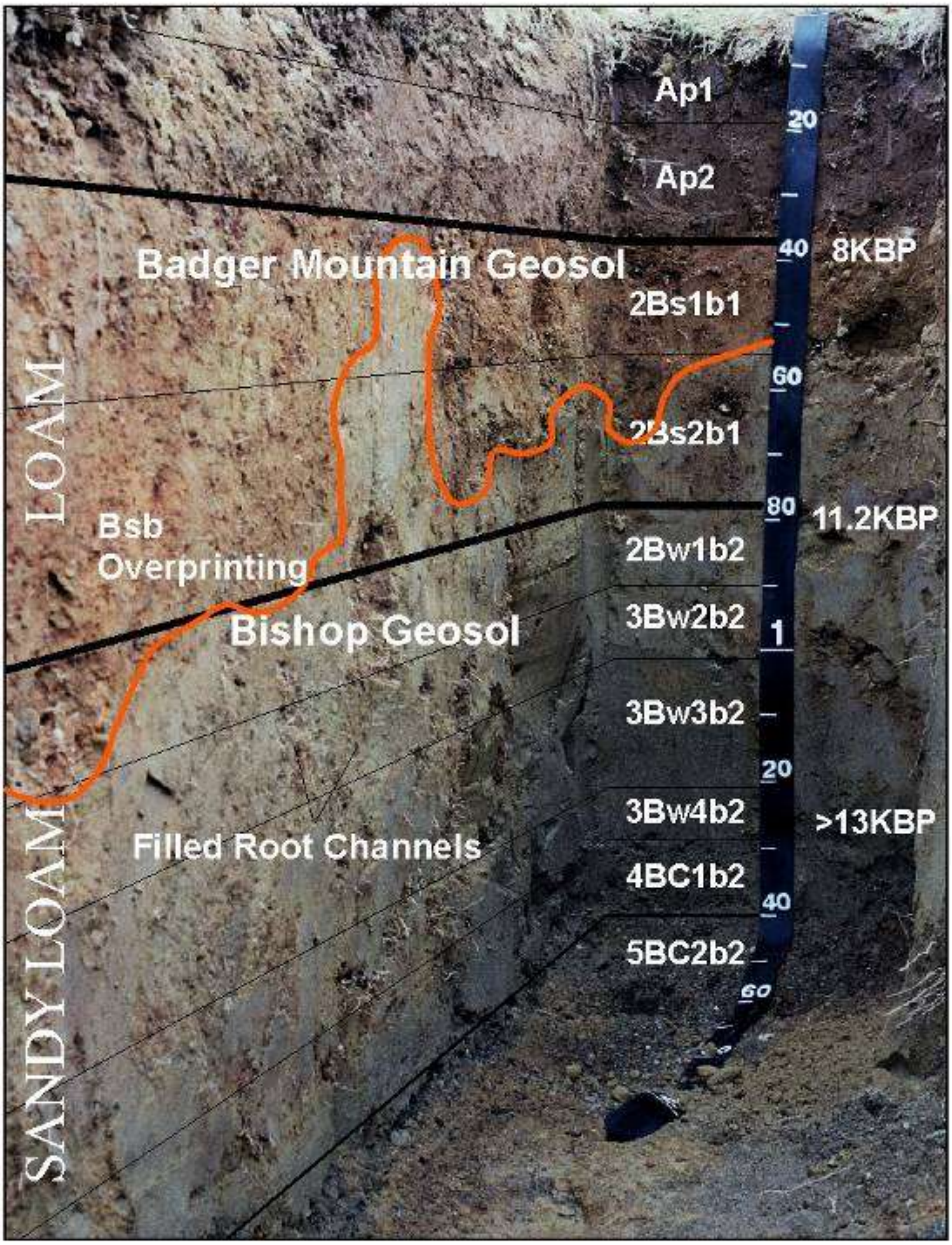


Figure 4.5 Typical exposure of the relationship between the Bishop and Badger Mountain geosols in forested environments west of the Cascade Mountain range.

One section in the Bishop type transect formed into a stack of rhythmically bedded megaflood deposits with an upper-Pleistocene loess mantle. At this location, 14 rhythmically-bedded sets of megaflood sediments are present, the lower 7 displaying reddish redox concentrations in root and worm channels, indicating an ameliorating moist environment. The 7 overlying rhythmites include very coarse faunal (cicada) burrow casts and a lack of redox concentrations, indicating shrub-steppe vegetation with relatively dryer climate. Mt. St. Helens Set S tephra (12.8 KBP) is present in the lower set of rhythmites, indicating a post-glacial-maximum stratigraphic position.

*Type transect locality*

The type transect of the Bishop geosol is located on the Babcock Bench, a structural bedrock erosional feature in the Grand Ronde formation near Quincy, Washington (Figure 4.6). Numerous floods throughout the Pleistocene have incised the upper basalt flow units, depositing a series of megaflood bars in the process. Topographic lows on the bench are filled with flood sediment, which is capped by an upper-Pleistocene and Holocene loess mantle. Near the southernmost end of the Babcock Bench, the Bishop geosol formed into a stack of rhythmically-bedded sediments that were deposited during the waning stages of the upper-Pleistocene megafloods.

The northern portion of the Bishop type transect is located at a Kolk, or a "plucked pothole" creating a local, enclosed basin. Kolks are formed during cross-scabland megafloods when an underwater vortex crosses a submerged surface with differential density in its upper portion. Sediments adjacent to the kolk consist of slackwater flood deposits in disconformable contact with the scoured basalt, overlain by local, eolian sediment deposited within the kolk basin. At this location, the compressed Bishop A

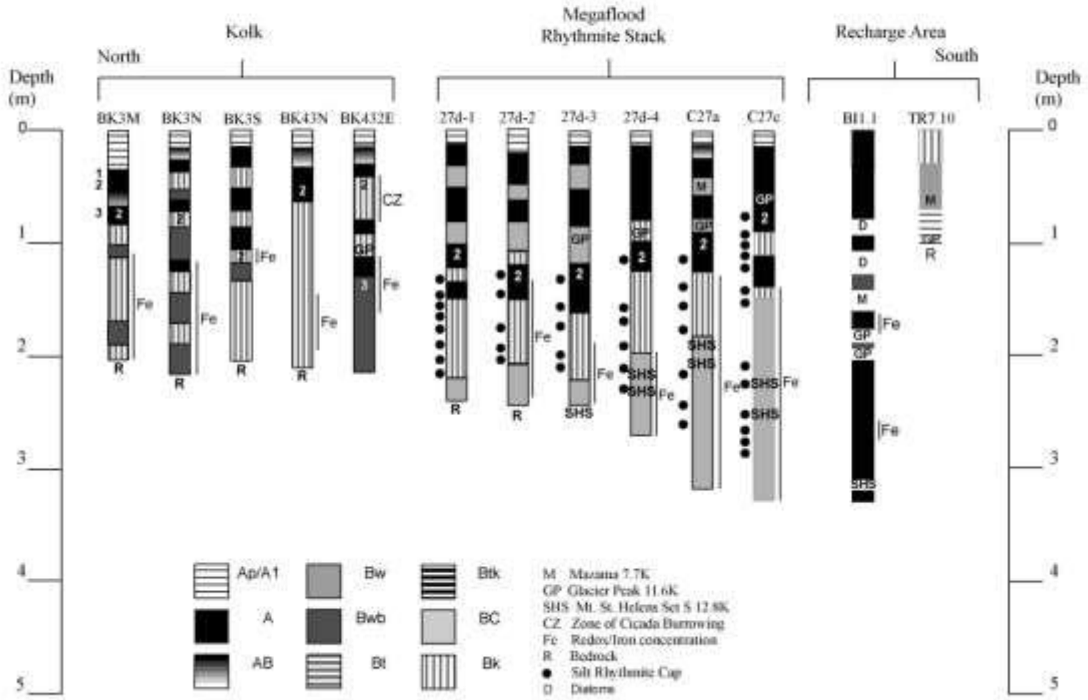


Figure 4.6 Type Transect Chart of the Bishop Geosol. Appendix 1, exposure trenches 27, 32, 35,36,37,38 and 39 make up the Bishop Type Transect.

horizon with platy structure, likely caused by compaction, includes fossil saltgrass rhizomes, deciduous tree leaves (Salix spp. L.) and insect bodies. Continuous lenses of Glacier Peak tephra occur at the same depth (Figure 4.7).

*Correlation to localized paleosols within the region*

The Bishop geosol correlates to the (informal) Rock Creek soil of Davis (2001) and to the Sand Hills Coulee soil of the (informal) upper Palouse Formation of the Columbia Plateau (McDonald and Busacca 1992, Busacca et. al 1992, Busacca and McDonald 1994). Similarly, research undertaken at the US Army Yakima Training Center in the late 1990s identified Bishop-age paleosols (Figure 4.7) within a series of

Table 4.1 Radiometric dates associated with the Bishop geosol

| **Location** | **Age** | **δC13** | **Date BP** | **Depositional Environment** | **Material** | **Reference** |
|---|---|---|---|---|---|---|
| Little Salmon River | 11,410 ±130 | N/A | 13390-13155 | Alluvial | Wood Charcoal | Davis and Schweger 2004 (TO-7349) |
| Little Salmon River | 11,320 ±80 | N/A | 13278-13133 | Alluvial | Wood Charcoal | Davis and Schweger 2004 (TO-7352) |
| Little Salmon River | 10,740 ±220 | N/A | 12929-12395 | Alluvial | Wood Charcoal | Davis and Schweger 2004 (TO-7351) |
| Cold Creek 3 Locale | 12,090 ±40 AMS | N/A | 14002-13862 | Alluvial | Total humates | Galm et. al 2000 (CAMS65978) |
| Cold Creek 3 Locale | 11,910 ±40 AMS | N/A | 13837-13716 | Alluvial | Total humates | Galm et. al 2001 (CAMS65981) |
| Type Transect | 12,100 ±60 AMS | N/A | 14022-13858 | Rhythmite Cap | Bone collagen | Hackenberger 2004 No lab# |
| Vantage, Wa | 12,800 ±-60 AMS | N/A | 15268-15019 | Megaflood deposit | Bone collagen | This Study (CAMS59589) |
| Wanapum Reservoir | 13310 ± 50 AMS | -25.1 o/oo | 16678-16178 | Paleolake Sediment | Total humates | This Study (Beta 284057) |
| Beezley Hills | 13560 ± 60 AMS | -22.6 o/oo | 16841-16640 | Loess | Total humates | This Study (Beta 282040) |

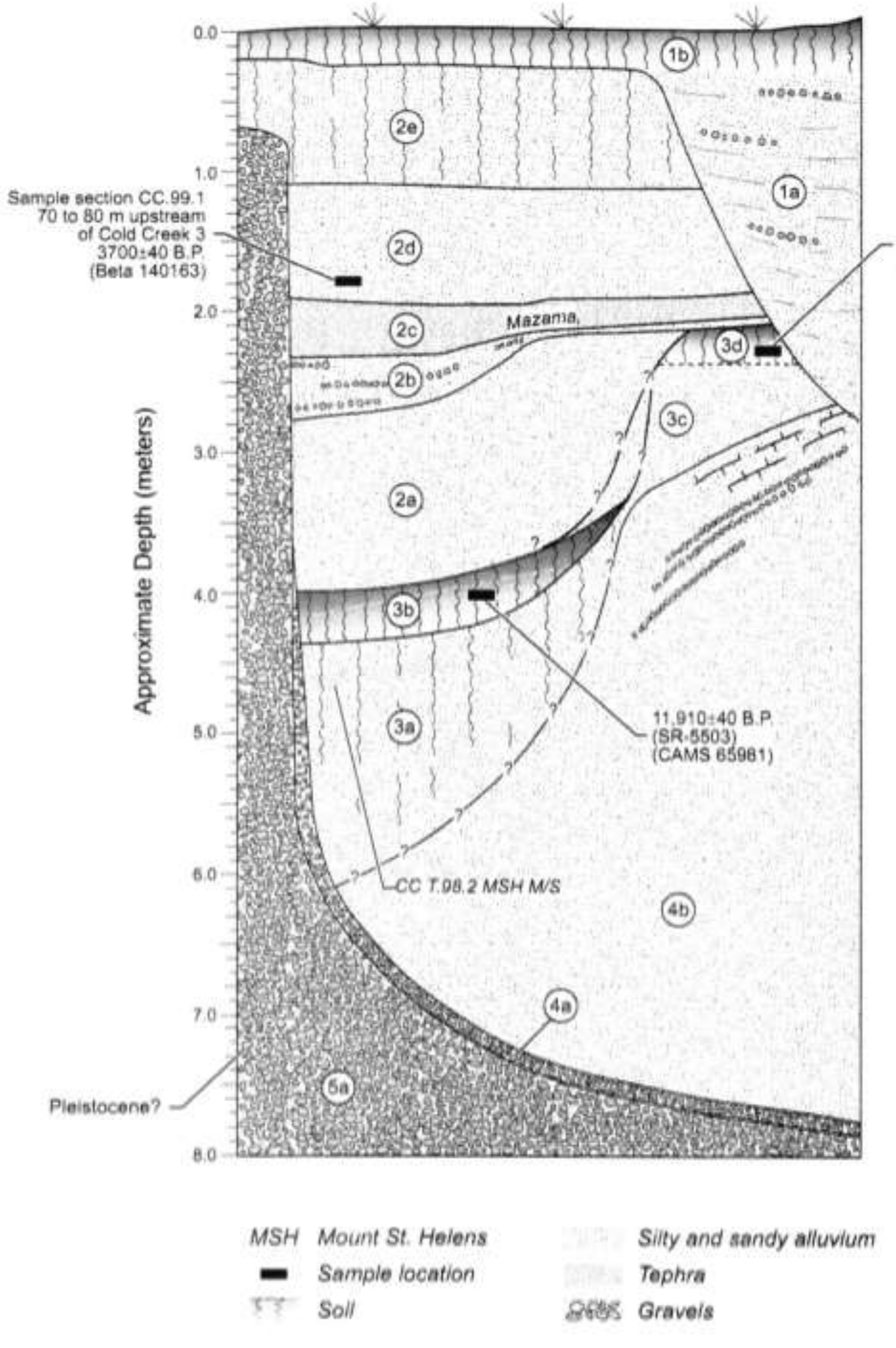


Figure 4.7 Bishop geosol section, Lmuma Creek. After Galm et al 2000

relatively small, tributary drainages to the main stem Columbia River (Galm et. al 2000; Galm and Gough 2000).

A variety of soil designations in County Soil Surveys east of the Cascade Range include evidence of the buried Bishop geosol. Concentrated deposits of Glacier Peak tephra are identified in the Renslow and Baghdad series in Grant County, overlying argillic B horizons (Gentry 1984). In a more recent soil survey for Douglas County, Washington, similarly higher concentrations of Glacier peak tephra have been identified in horizons overlying argillic horizons which include the Farmer and Dougville soil series (Beiler and Kehne 2008).

*Tephrochronology*

The upper boundary of the Bishop geosol is often in contact with tephra correlated to the eruption of Glacier Peak. Glacier Peak tephra is common as a couplet or triplet with Mt. St. Helens Set J tephra, and there is some overlap in their documented ages (Kuehn et. al 2009).

**Profile Characteristics**

The Bishop geosol differs from the Badger Mountain soil by having only relatively rare faunal burrows (cicada) and less carbonate cementation. Its thickness is highly variable, depending on the environment of deposition. In the cap of megaflood sediments it is relatively thin, with higher carbonate cementation at its contact with coarse sand and cobbles. The A horizon of the Bishop geosol displays dark, very sandy loam horizons.

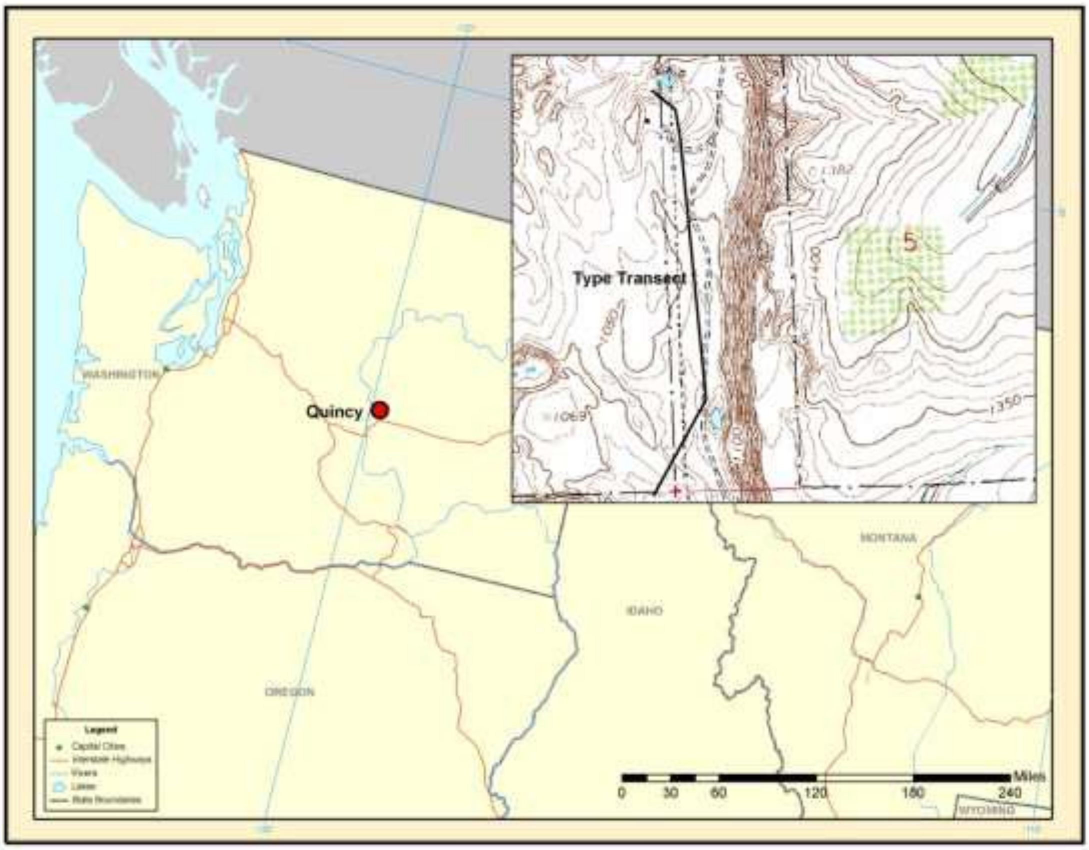


Figure 4.8 Location of Bishop geosol Type Transect on the USGS Babcock Bench Quadrangle near Quincy, Washington

The full thickness of the Bishop geosol is generally between 10 to 30 centimeters in sand and gravelly sand, but it ranges from as much as 1.5 meters in loamy sand to as little as 5 centimeters in perched bedrock settings. Its upper boundary is often characterized by a disconformity with the Glacier Peak tephra west of the Cascade mountain range, typically in open depositional settings such as broad plains that were subject to deflation, and as a weak Bw horizon in forested settings west of the Cascade range.  Its base is rooted in megaflood sediment west of the Cascades and in glacially-deposited sediment and glacio-fluvial alluvium west of the Cascades.

*Age*

The age of the Bishop geosol is constrained by relative stratigraphic position of air-fall tephra and direct radiocarbon dates of charcoal, bone and humates within the soil. Dates range from 11.9 to 12.8 KBP (Table 4.1 displays the known 14C dates associated with the Bishop geosol).  The Bishop geosol formed into the cap of megaflood sediment which includes Mt. St. Helens Set S tephra, providing a relative and minimum limiting age for the base of the Bishop geosol of 12.8 KBP at the Type locale.

**Badger Mountain Geosol**

*Narrative Overview*

The Badger Mountain geosol post-dates deposition of Glacier Peak tephra and pre-dates Mazama (7.7 KBP) tephra.  It is characterized by multiple, stacked buried A (Ab) horizons, Cambic horizons and well developed Argillic horizons.  In arid portions of the central, interior Columbia Plateau, it includes prominent carbonate filaments in the Bk horizon and cicada cementation in a zone up to 1.5m thick, with carbonate cementation in many exposures.  These B horizons overprint the Bishop geosol in some exposures on colluvial slopes and in local depositional basins.  Where Mazama tephra is present, the Badger Mountain paleosol immediately underlies the tephra, indicating that Mazama fell on the stable Badger Mountain surface.  In some locations the relationship is disconformable, typically in open depositional settings such as broad plains that were subject to deflation.

The age of the Badger Mountain geosol is constrained by relative stratigraphic position of air-fall tephra and direct radiocarbon dates on charcoal (9.7 KBP).  The Badger Mountain geosol formed after deposition of Glacier Peak tephra and prior to deposition of Mazama tephra (7.7 KBP).  In the interior northwest the Bishop and Badger Mountain Geosols are often separated by sediment deposition that is coeval in time with the Younger Dryas cooling episode.

The Badger Mountain geosol formed after deposition of Glacier Peak tephra and prior to deposition of Mazama tephra (7.7 KBP).  In many exposures, the Badger Mountain paleosol is buried by Mazama tephra, a stratigraphic relationship which supports a relatively late shift to altithermal conditions, as suggested by regional pollen records which indicate a warmer and drier climatic regime based on the expansion of xeric plant species and an increase in sagebrush and grass communities during this period of time (Mehringer 1985; Wigand 1989).   The Bishop and Badger Mountain Geosols are [generally] separated by a non-loess eolian depositional event that is coeval in time with the Younger Dryas cooling episode.  The relatively cool, dry climate of the Younger Dryas precluded soil formation into the eolian material until the close of Younger Dryas during Badger Mountain time.

*Stratigraphic Relations and Occurrence*

The Badger Mountain geosol is the most widely distributed soil in the region.  It is not only widespread on the lowlands—along main stem Columbia and Snake River bottoms—but also is the most consistently expressed soil in the uplands above the highest shoreline of the Missoula flood sediments in the central Columbia Plateau because older soils such as the Bishop geosol generally has either been eroded or buried by younger sediment. This soil is considerably weaker than older Pleistocene soils of Busacca et al. (1992), but is much more strongly developed than the Bishop or Willow Lake geosol and the Bishop geosol at many locations, and is one of the most useful stratigraphic markers for archaeological and geologic research. The Badger Mountain geosol is not evident on some relict exposures of the Bishop geosol, particularly in shallow depositional environments, because it is masked by the stronger development of the older soil, even though it is generally the most commonly expressed of the Geosols in the Pacific Northwest Region.

*Type Transect locality*
The type locality of the Badger Mountain soil is located at the base of the Badger Mountain anticline near East Wenatchee, Washington (Figure 4.9 and Figure 4.10). This location is situated on "the world's most colossal point bar" as described in Waitt and Atwater (1989). The soil formed into upper Pleistocene megaflood sands and colluvially-redeposited sandy silts which unconformably overlie highly indurated middle Pleistocene megaflood sediments. The geosol is buried by up to a meter of Holocene eolian sand.

*Correlation to localized paleosols within the region*
The Badger Mountain soil correlates to the (informal) Rock Creek soil of Davis (2001) and to the Sand Hills Coulee soil of the (informal) upper Palouse Fm. (McDonald and Busacca 1992, Busacca et. al 1992, Busacca and McDonald 1994). A variety of soil designations in Soil Surveys east of the Cascade Range include evidence of the buried Badger Mountain geosol in their type sequence. The Adkins, Ritzville, and Shano series soils have cambic B horizons which represent the Badger Mountain geosol. Gentry (2001) identified 90 percent very coarse intersecting

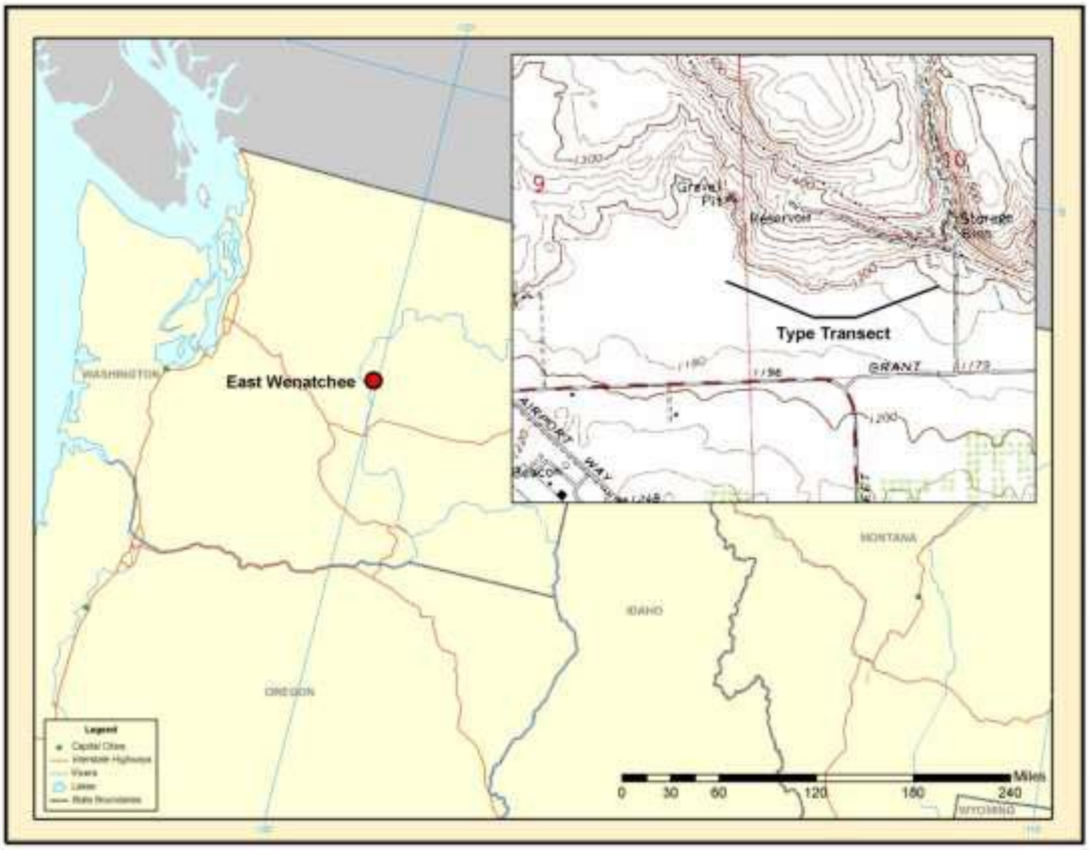


Figure 4.9 Location of Badger Mountain geosol Type Transect, Dounglas County, Washington State. Appendix 1, exposure trenches 33, 43, 55,56,57,58 and 59 make up the type transect.

cylindrical cicada casts in the upper part of the argillic B horizon for the Volinger series in the Kittitas County Soil Survey. Depth to the argillic horizon for Volinger series soils is shallow, between 12 to 19 inches. Overlying the argillic Bt horizon the paleosol has 5 to 20 percent volcanic glass content and 5 to 10 percent very coarse cicada casts underlying the Ap horizon. The argillic horizon has dry consistence of very hard as compared to the overlying horizon dry consistence of slightly hard, many very fine roots in the vertical seams and it has a second underlying Bw horizon.

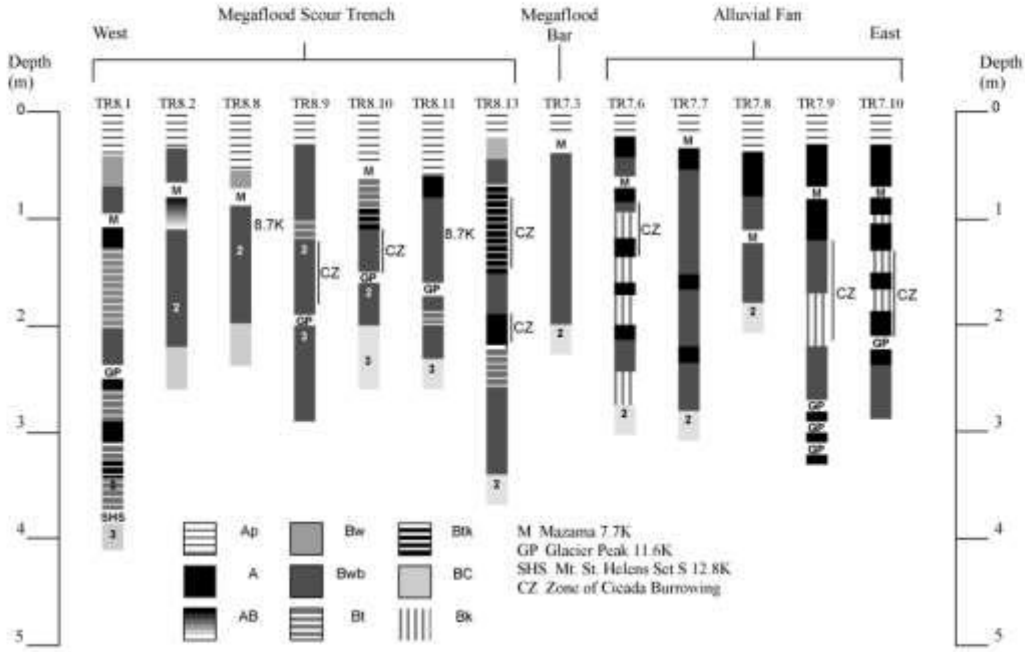


Figure 4.10 Type Transect of the Badger Mountain Geosol

*Tephrochronology*

The upper boundary of the Badger Mountain geosol is often in contact with tephra correlated to the climactic eruption of Mt. Mazama (Zdaniwicz 1999). While Mazama tephra is a ubiquitous constituent of Holocene sediments throughout the region, burial and preservation of Mazama tephra in situ was dependent on the environment of deposition. Sedimentary environments conducive to burial and preservation of the Mazama, in or ex-situ, include loess, alluvial fans, alluvium and colluvial settings (in order of most common occurrence). Vegetation was a clear factor in the retention of Mazama tephra. Soils such as the Tolo series have a mantle of volcanic ash that had an overstory of conifers during even the driest periods, resulting in the retention of the volcanic ash in the sediment column (Gentry 1991). A key point of departure from the definition of the Sand Hills Coulee paleosol exists at the lower boundary of the deposit. The lower tephra boundary for the Sand Hills Coulee paleosol was placed at the lithostratigraphic marker horizon of the Mt. St. Helens Set S tephra. The present study recognizes a break in pedostratigraphy between the Badger Mountain and Bishop geosols, the latter of which formed prior to and after deposition of Mt. St. Helens Set S tephra. The base of the Badger Mountain geosol overlies tephras that correlate to the eruptions of Glacier Peak and Mt. St. Helens Set J (both at ~11.6 KBP) (Kuehn, 2009; Mullineaux 1986).

**Profile Characteristics**

The Badger Mountain geosol differs from the Bishop and Willow Lake soils by being considerably thicker and in most locations, it is more strongly developed. Its full thickness is generally about 10 to 40 centimeters in sand and gravelly sand, but it ranges from as much as 20 centimeters in gravel to as little as 5 centimeters in silt and clay. Its upper boundary is often characterized by a disconformity with the Mazama tephra, typically in open depositional settings such as broad plains that were subject to deflation. In every instance where Mazama tephra is present in the exposed profile, the Badger Mountain Geosol immediately underlies the tephra, usually with an unconformable contact.

Its top varies, depending on depositional environment. On fine-grained alluvial fans and in alluvium, it is characterized by multiple, stacked buried A (Ab) horizons. In deep alluvium it is present as alternating A-C or A-Bw horizons. In areas of high groundwater flow through overlying Mazama tephra, the Badger Mountain geosol is expressed as a Bkqb horizon with concentrations of carbonate-silica nodules between 1-3cm. in diameter. Vesicular (Ab) horizons are present in places; Skeletans exist on many of the ped faces underlying the Badger Mountain Ab horizon in settings where the dispersion of clay occurred. These B horizons overprint the Bishop paleosol in some exposures on colluvial slopes and at the base of local depositional basins, as at its' type site. Beneath this is a cambic (Bw) horizon, and well-developed argillic horizons, representing natric conditions. These are underlain by a Bk horizon which includes prominent carbonate filaments and cicada cementation as much as 1.5m thick, with carbonate cementation up to 15% in many exposures. Typically, although not always, the Bk horizon has 20-30% cemented cicada casts, with some exposures as much as 90%. The full profile of this soil is preserved more commonly than that of any of the other geosols.

The profile varies less with variations in parent material and other local environmental factors than do the Bishop and Willow Lake soils, not only in total thickness, but also in details of the A and B horizons. For example, the A horizon is well developed in fine-grained alluvial fans and in alluvium. The Bk horizon is strongly developed in silt to sand, and weakly developed in clean gravel and sand. In thin profiles, those with less than one meter total sediment overlying the C horizon, the Bk horizon overprints the underlying Bishop soil. Both soils are together expressed as prominent calcareous accumulations on the underside of gravel, cobbles and boulders. The following general horizon descriptions refer only to locations that are relatively flat and well-drained, where the soil is relatively uneroded, and where it developed on sand or gravel.

*Age*

Radiometric ages of the Badger Mountain geosol are based on 14C dating of charcoal and Total humates within the soil. Dates range from 8,880±70 years to 10,940±70, although the latter date is based on alluvially-deposited charcoal and likely reflects only the age of the burned material, rather than the age of the soil which formed into the alluvium. Table 4.2 displays the known 14C dates associated with the Badger Mountain geosol.

Table 4. 2 Radiocarbon dates associated with Badger Mountain geosol

| Location | Age | δC13 | Date BP | Depositional Environment | Material | Reference |
|---|---|---|---|---|---|---|
| Cow Creek | 6120 ± 40 AMS | -24.5 o/oo | 7156-7115 | Alluvial Terrace | Total humates | This work (Beta282908) |
| Cow Creek | 7610 ± 40 AMS | -24.9 o/oo | 8427-8381 | Alluvial Terrace | Total humates | This work (Beta283874) |
| Beezley Hills | 7820 ± 40 | -23.2 o/oo | 8631-8556 | Loess | Total humates | This work (Beta282038) |
| Type Transect | 9800± 60 | N/A | 11254-11183 | Megaflood bar | Charcoal | Mehringer and Waitt 1990: No reference # |
| Corral 2 locale | 9010± 90 | N/A | 10250-10121 | Alluvium | Total humates | Galm et. al. 2000 (Beta139124) |
| Corral 2 locale | 9100± 60 | N/A | 10298-10192 | Alluvium | Charcoal | Galm et. al. 2000 (Beta140172) |
| N. Fork Lmuma Creek | 9810± 60 | N/A | 11261-11218 | Alluvium | Charcoal | Galm et. al. 2000 (Beta140170) |
| N. Fork Lmuma Creek | 9910± 60 | N/A | 11394-11239 | Alluvium | Total humates | Galm et. al. 2000 (Beta139128) |
| N. Fork Lmuma Creek | 9320± 120 | N/A | 10684-10376 | Alluvium | Total humates | Galm et. al. 2000 (Beta139127) |
| N. Fork Lmuma Creek | 9520± 120 | N/A | 10890-10877 | Alluvium | Total humates | Galm et. al. 2000 (Beta139126) |
| N. Fork Lmuma Creek | 10480 ±120 | N/A | 12560-12373 | Alluvium | Total humates | Galm et. al. 2000 (Beta139125) |
| N. Fork Lmuma Creek | 9860± 90 | N/A | 11400-11184 | Alluvium | Total humates | Galm et. al. 2000 no lab# |
| N. Fork Lmuma Creek | 10350 ±60 | N/A | 12223-12081 | Alluvium | Total humates | Galm et. al. 2000 no lab# |
| N. Fork Lmuma Creek | 10150 ±90 | N/A | 12004-11617 | Alluvium | Total humates | Galm et. al. 2000 no lab# |
| N. Fork Lmuma Creek | 10000 ±90 | N/A | 11626-11303 | Alluvium | Total humates | Galm et. al. 2000 no lab# |
| Sentinel Gap Site | 9630± 40 AMS | N/A | 10953-10868 | Alluvium | Total humates | Galm et. al. 2000 (CAMS6597) |
| Sentinel Gap Site | 8880± 70 AMS | N/A | 10170-9903 | Alluvium | Total humates | Galm et. al. 2001 (Beta124168) |
| Selah Creek Gabion Locale | 10,940 ±70 AMS | N/A | 12900-12697 | Alluvium | Charcoal | Galm et. al. 2002 (Beta140164) |
| Selah Creek Gabion Locale | 10,020 ±40 AMS | N/A | 11615-11395 | Alluvium | Charcoal | Galm et. al. 2003 (CAMS6598) |

**Willow Lake Paleosol**

The Willow Lake Paleosol is a late Holocene buried soil that is present across the Columbia Plateau, west of the Cascade Range. While it is pervasive in many environments, I have not seen it cross all depositional settings as the Badger Mountain and Bishop geosols. Likewise, a geosol is required to be buried by a named geologic body; the Willow Lake Paleosol underlies the modern surface soil and no other marker beds.

This short description of the Willow Lake Paleosol is intended to re-introduce the concept of a regional soil that was broadly known several decades ago (Fryxell and Cook 1964). I have not concentrated much in the way of time on the Willow Lake soil as it is a late Holocene paleosol and the focus of my research is related to the Upper Pleistocene and Holocene, at least for the purpose of this dissertation. Although I have completed documentation on many stratigraphic sections across the Columbia Plateau that include the Willow Lake paleosol, I do not have sufficient data to characterize the paleosol fully, so the following discussion is brief. I refer the reader to Appendix 2 for many stratigraphic descriptions that include some detail of this soil.

*Narrative Overview*

Fryxell and Cook (1964) characterized the Willow Lake paleosol (although not by the Willow Lake name) as a "post-Altithermal paleosol generally expressed by A-C profiles of minimal development, a transitional horizon that is horizonated as an AB horizon". Figure 4.11 shows an alluvial section from the U.S. Army Yakima Training Center which contains exposures of the Willow Lake Paleosol.

*Stratigraphic Relations and Occurrence*

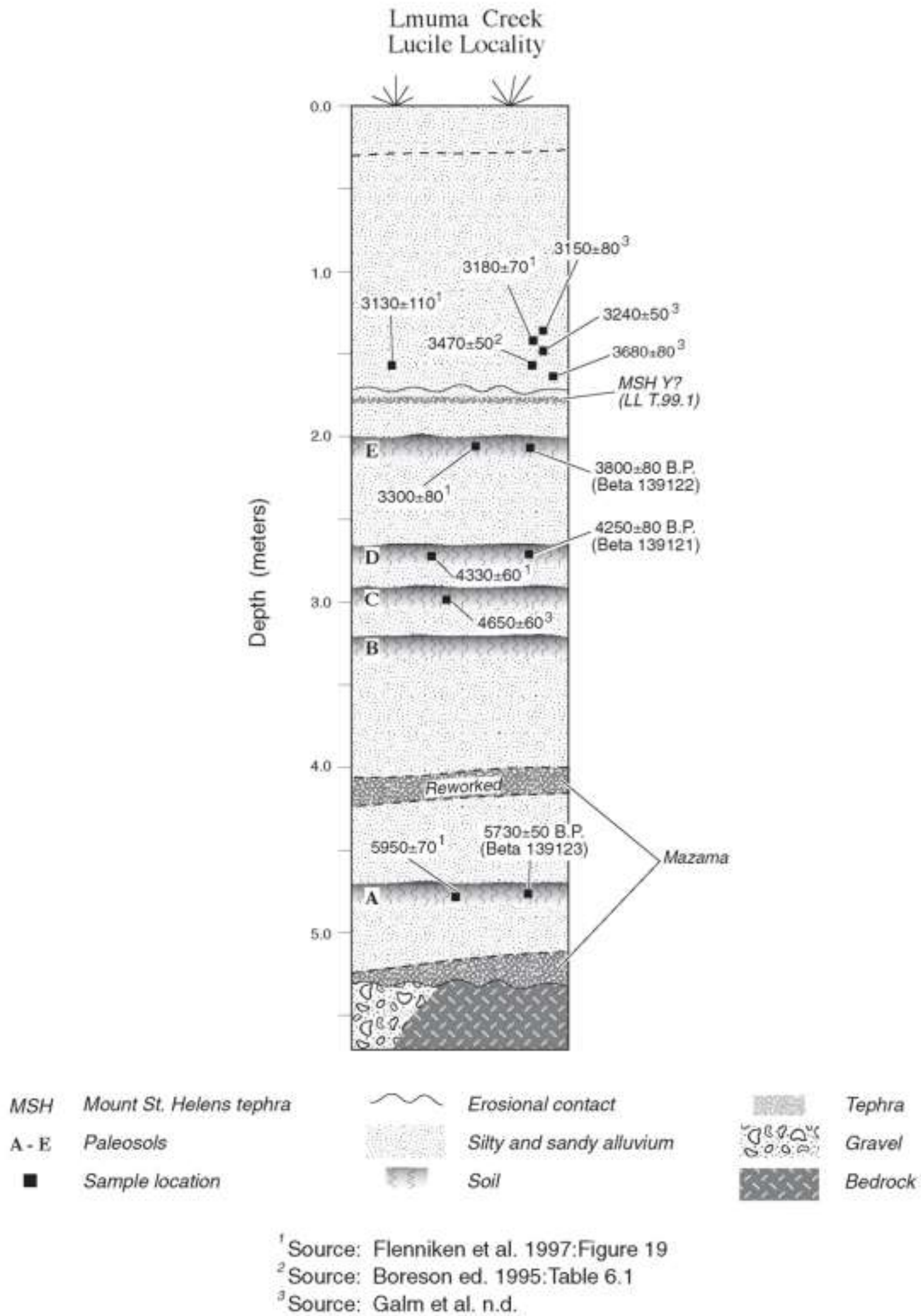


Figure 4.11 Willow Lake Paleosol section, Lmuma Creek (Table 4.3). After Galm et al. 2000.

Stratigraphically the Willow Lake Paleosol overlies the Mazama tephra with a gradual decrease in tephra nearer the surface of the profile (at locations with Mazama tephra).

At some locations in the drier portions of the Columbia Plateau, the lower boundary of the Mazama appears to be unaltered or more like a C horizon, hence, the A-C designation by Cook and Fryxell.

*Age*

Radiometric ages of the Willow Lake geosol are based on 14C dating of charcoal and Total humates within the soil. Dates range from 5950±70 years to 3300±80. Table 4. 3 displays the known 14C dates associated with the Willow Lake geosol. Appendix 1 lists the location of stratigraphic sections (termed "exposure trenches") that contain additional pedostratigraphic detail about the soil.

Table 4. 3 Radiocarbon dates associated with Willow Lake Paleosol

| **Location** | **Age** | **Cal Age BP** | **Depositional Environment** | **Material** | **Reference** |
|---|---|---|---|---|---|
| Lucille Locale | 3300±80 | 3,631-3,623 | Alluvium | Total humates | Galm et. al 2000 (Beta100995) |
| Lucille Locale | 3800±80 | 4,382-4,374 | Alluvium | Total humates | Galm et. al 2000 (Beta139122) |
| Lucille Locale | 4250±80 | 4,950-4,944 | Alluvium | Total humates | Galm et. al 2000 (Beta139121) |
| Lucille Locale | 4330±60 | 4,967-4,845 | Alluvium | Total humates | Galm et. al 2000 (Beta100996) |
| Lucille Locale | 4650±60 | 5,466-5,347 | Alluvium | Total humates | Galm et. al. n.d. No lab# |
| Lucille Locale | 5730±70 | 6,632-6,585 | Alluvium | Total humates | Galm et. al 2000 (Beta139123) |
| Lucille Locale | 5950±70 | 6,881-6,872 | Alluvium | Total humates | Flenniken et. al 1997 (Beta100997) |

*Narrative Overview*

Fryxell and Cook (1964) characterized a post-Altithermal paleosol as being generally expressed by A-C profiles of minimal development, a transitional horizon that is currently horizonated as an AB horizon (Figure 4.11). Stratigraphically it overlies the Mazama tephra with a gradual decrease in tephra nearer the surface of the profile at locations with Mazama tephra. At some locations in the drier parts of the state, the lower boundary of the Mazama appears to be unaltered or more like a C horizon.

# CHAPTER 5
# LITHIC RESOURCES

## Introduction

The purpose of this chapter is to examine the nature of lithic resources in the Pacific Northwest, focusing on baseline stone that Colonizers had opportunity to discover and exploit. I describe the context of the Columbia River Basalts which are the source of petrified wood and agates, the predominant lithic raw material in the region, details of a new source of stone, the Beezley Chalcedonies, and I introduce a cache of stone tools with Clovis affinities, made from Beezley chalcedony.

The archaeological literature includes references to Paleoindian preference for high-quality, fracture-plane and bedding-plane-free, inclusion-free lithic materials (microcrystalline quartzes such as chalcedonies and cherts in particular; Beck and Jones (1990); Daniel (1996); Frison (1987); Kelly and Todd (1988); O'Steen (1996); Pitblado (2003). In the Pacific Northwest, cherts and chalcedonies are the predominant tool stone type during the Colonizer period. Extensive obsidian use is clear (specific examples are noted by site in Chapter 2); particularly as proximities to obsidian sources in Oregon and Idaho shorten. In the central Columbia Plateau and along the coast, obsidian use must represent either direct extraction by foraging groups travelling from the obsidian sources in the south (central to southern Oregon) or the east (Idaho), or it may also represent trade and exchange (Galm 1994). In either case, it is usually possible to identify the source of the obsidian, which facilitates tracking either of these possibilities. Willis (2003) suggests that significant coastal-inland interaction at the Indian Sands site took place during the late Pleistocene--obsidian and other volcanic lithic use is clear. Willis argues that whether or not the lithic resources were obtained by trade or exchange, interaction networks in one form or another were in place at a very early date. By 10.4 KBP, either extensive trade networks with interior groups, or direct procurement was taking place.

To the south, in the northern Great Basin, Beck and Jones (1990), Amick (1995) and Basgall and Hall (1993) found that Obsidian and fine-grained igneous stone (e.g. basalt, andesite, dacite, rhyolite, and felsites), were actually preferred to chert among makers of Great Basin Stemmed Series points, a regional correlate to the Western Stemmed Tradition. Preference for obsidian and volcanic stone among these early stemmed point makers is clear despite sources of chert in closer proximity to the use areas (Basgall, 1993a, b; Basgall and Hall, 1991; Beck and Jones, 1988, 1990a, b). This is in stark contrast to decisions made by makers of fluted points who clearly preferred cherts and other hard, stable stone source. Beck and Jones (1990) suggest that differences in tool function may account for this preference, with the relatively stronger cherts used for fluted projectiles. They suggest that stemmed bifaces may have served dual roles, not simply as projectile tips.

While geochemical sourcing at archaeological sites may describe the distance which a given toolstone was moved from its source, it can't explain the cultural process that led to its arrival there (via trade/exchange or by direct acquisition: Binford 1980). But with enough data from a variety of sites, it is possible to at least understand the Colonizer interaction sphere, if not the total range of land utilization. Unfortunately, the regional data is exceedingly scant at this stage. Compounding this issue is the unfortunate fact that, at least to date, we are unable to successfully geochemically characterize the range of agates and chalcedonies that are so abundant in the region.

Many authors have shown the relationship between mobility and settlement among foraging groups and abundance of high quality lithic raw material (Andrefsky 1995; Bamforth 1986). In regions where high quality lithic raw material is abundant, such as the Pacific Northwest, colonizer archaeological sites contain the highest proportion of these materials. On the other hand, in areas without decent material, high quality stone is curated. Other examples of this occurrence are known from Paleoindian sites in the North American Great Plains, where exceedingly high quality Knife River Flint is available in abundance and exotic lithics (from sources 100-300 miles away) are minimal and usually limited to discarded tools (MacDonald 1999; Root et al. 2000).

**Heat Treatment of Lithic Raw Material**

Colonizer toolkits in the Pacific Northwest display evidence for heat treatment (details by site in Chapter 2), a procedure which greatly improves the flaking properties of lithic raw material. This process involves slowly heating the stone and maintaining the temperature, gradually reducing it back to normal. Heat treatment was first described by Crabtree and Butler (1964) and across North America the waxy texture and luster of flaked-stone artifacts indicate it was a process known and used by Paleoindian peoples.

Crabtree demonstrated that heat treatment can be accomplished easily by burying the stone in sand under a campfire that is maintained for a number of hours. The process is most successfully accomplished if the stone is first reduced by percussion to large flakes and trimmed to the size and shape of early-stage bifaces to promote even heating throughout and reduce the chance of breaking. Other difficulties related to heat treatment include excessive heating and the presence of excess water in lithic raw material, which can both lead to "pot-lids", flat and circular failures of the stone (Purdy 1975). Raw material that is heated properly has improved flaking qualities, and flake removals from the heated core have a waxy, lustrous appearance as compared to portions of the core that maintain the pre-heated core cortex (Rick and Chappell 1983).

Heat treatment of raw tool stone is evident in the Richey-Roberts assemblage by waxy texture and luster. Damage by heat treatment (crazing and pot-lidding) dominates the Winchester Wasteway assemblage (Chapter 2) and is displayed in the majority of artifacts found there.

**Lithic Sources**

*Silicified Woods and Bogs*

The petrified woods of the Miocene Columbia River Basalt Group (hereinafter CRBG) are well known throughout the Pacific Northwest Region. The CRBGs contain extensive sediment interbeds with concentrations of flakable lithic raw material. Several source locations for petrified wood are known from areas west of the Cascades

Range as well. Anonymous (1936) and Beck (1941) describe petrified wood from the Chehalis Valley. Regional rock hound guides refer to wood at Salmon Creek near Toledo, at Silver Lake near Kelso and at Tono. Pattie (1983) notes that in rare cases petrified wood can also be found on coastal beaches of Washington State.

*Lithic raw material of the Columbia River Basalt Group*
The intent of this section is to introduce a new, high quality lithic raw material resource area here termed the Beezley Chalcedony. My goal is to provide an overview of the bedrock stratigraphic background and setting in a manner that will provide context for the broader issue of the raw material source.

Before discussing details of the stone source, it is important to define some basic terms. I prefer to use the generic term Chalcedony for the Beezley source, defined here as a cryptocrystalline form of silica, made up of intergrowths of the minerals quartz, a mineral with trigonal structure and moganite, a monoclinic mineral (Heaney 1994; Heany and Post 1992). Two forms of chalcedony occur in the Beezley source area. The first, agate is a banded, multi-colored variety of chalcedony that often occurs in tabular form. In the Beezley hills the highest quality agate is translucent, check-free and inclusion-free with superior conchoidal fracture. The second, jasper, is an opaque form of chalcedony, in the Beezley hills it is usually brick red, dark yellow or brown in color. A third form of silica mineral, opal, occurs with the chalcedonies, it is an amorphous or non-crystalline form of silica, usually white, but may grade into yellow and green. Opal in the Beezley source area tends to have no fracture properties that are conducive to stone-tool production as it shatters even with relatively gentle force.

Although in previous chapters I've referred to the interior of the Pacific Northwest in a generic sense as the "Columbia Plateau", within the context of this section, it is appropriate to refer to it slightly differently. The Beezley Hills study area that contains the toolstone is located within the Yakima Fold Belt subprovince of the Columbia Basin section of the Columbia Intermontane Province (Figure 5.1; Rosenfeld 1993). The concept of the interior section of the broader Columbia Plateau as a "basin" has particular importance with regard to its structural bedrock setting. The Columbia Basin is an irregular, structural and topographic basin, formed primarily during the Tertiary Period as lava that was extruded in sheet-like flows covered most of central Washington State (Figure 5.2). These lava flows are the Columbia River Basalt Group (Easterbrook and Rahm 1970), generally more than 3,500 m in thickness, covering an area greater than 200,000 sq km (Figure 5.1; Myers and Price 1979).

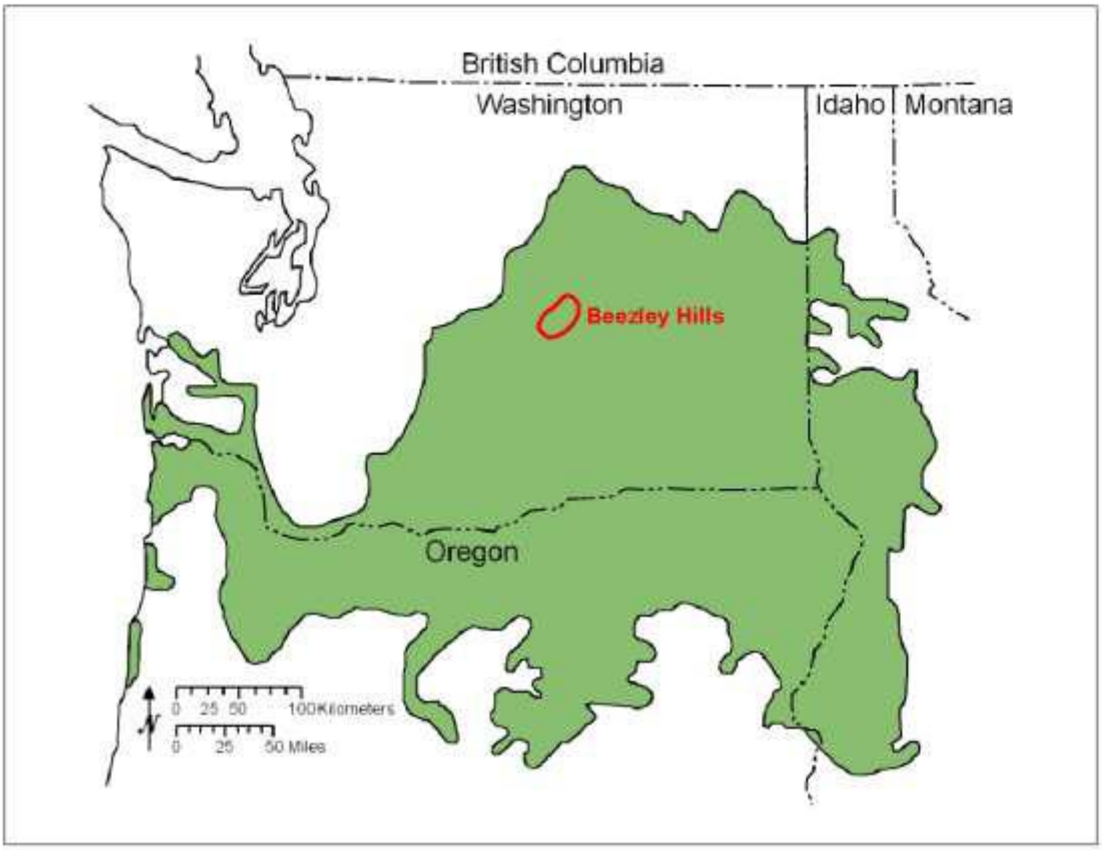


Figure 5.1 Location of the Beezley Hills within the extent of the Columbia River Basalt Group (Solid Green)

| SERIES | | GROUP | SUB-GROUP | FORMATION | MEMBER | MAG |
|---|---|---|---|---|---|---|
| MIOCENE | Upper | Columbia River Basalt Group | Yakima Basalt Subgroup | Saddle Mountain Basalt | Lower Monumental Member | N |
| | | | | | Ice Harbor Member | N |
| | | | | | Buford Member | R |
| | | | | | Elephant Mountain Member | R, T |
| | | | | | Pomona Member | R |
| | | | | | Esquatzel Member | R |
| | | | | | Weisenfels Ridge Member | N |
| | | | | | Asotin Member | N |
| | | | | | Wilber Creek Member | N |
| | | | | | Umatilla Member | N |
| | Middle | | | Wanapum Basalt | Priest Rapids Member | R |
| | | | | | Roza Member | T, R |
| | | | | | Frenchman Springs Member | N2 |
| | | | | | Eckler Mountain Member | N2 |
| | | | | Grand Ronde Basalt | Sentinel Bluffs Member | N2 |
| | | | | | | R2 |
| | | | | | | N1 |
| | | | | | | R1 |
| | Lower | | | Imnaha Basalt | | R1 |
| | | | | | | T |
| | | | | | | N0 |
| | | | | | | R0 |

Figure 5.2 Stratigraphy of the Columbia River Basalts (After Swanson et al. 1979)

Prehistoric use of the Columbia River Basalts, both direct (utilization of the stone as lithic raw material) and indirect (utilization of basalt flow features) varies through time. Exposed in the steep cliffs along much of the mainstream Columbia and Snake River trenches, the basalts contain lava tubes, bubbles, and vents. Openings in the cliff faces, some of which were created by erosion of structurally weak zones of columnar cooling in the basalt, form caves or rockshelters. Colonizers used these rockshelters and caves for habitation, storage facilities, and as burial locations (Kirk and Daugherty 1978). Extensive rock-art panels are present on the faces of well-formed basalt columns, but these are concentrated in the middle to late portion of the Holocene (Figure 5.3).

Figure 5.3 Holocene rock glyph on columnar basalt face

Extensive talus slopes, formed from mechanical weathering of the cliff faces, are present along most of the basalt anticline fronts. Along the Columbia and Snake River trenches, basalt cliff faces were thoroughly scoured by Upper Pleistocene megafloods along their lower sections—it is possible, even likely that some Colonizer period cliffs or rockshelters have been covered by the extensive talus (Figure 5.4).

Figure 5.4 Extensive talus slope covering the lower portion of the buried cliff face, Columbia River Basalt Group, Wallula Gap, Washington State.

Interbed deposits mark the sedimentary basins that developed between successive lava flows across the Region. Interbed drainages produce springs along slope exposures and at the contacts between alluvial terraces and steep cliffs. These springs were attractive habitats for plants and animals and were frequently the locations of prehistoric encampments. These fossil-rich interbeds contain silicified remains of plants and trees. One prominent interbed, termed the Ellensburg Formation, is reported to provide most of the petrified wood and other siliceous stone used as raw material for stone tool manufacture by the prehistoric inhabitants of the region (Bicchieri 1999; Danz 1999; Hunger and McCutcheon 1999). Benson et al. (1989) first recognized the association between prehistoric lithic raw material quarries and the Ellensburg Formation basalt interbeds. In their study the authors created GIS overlays in order to examine relationships between the interbeds and prehistoric site locations. Other authors have also considered petrified wood sources from the Sentinel Bluffs area of the middle Columbia River (Bender 1980; Bicchieri 1999; Danz 1999; Hunger and McCutcheon 1999).

These interbeds are exposed in several areas, most prominently along the Saddle Mountains and other ridges of the Yakima Fold Belt, along the Columbia River near Vantage, and in the Beezley Hills. Although petrified woods and bogs, opals and agates are relatively widespread in their distribution, flaking qualities of the stone are highly variable. The Beezley quarries, the focus of this portion of the dissertation, are exceedingly high-quality lithic raw material sources found within a narrow range of basalt flow units, as described below.

## Flood Basalt Origin and Dynamics

To understand details of the origin of the Beezley Chalcedonies it is best to review dynamics of the Columbia River flood basalts. During the middle Miocene period, sixteen million years ago, immense heat was concentrated below the Hells Canyon, along the Oregon and Idaho State borders. Bedrock began melting at depth, causing basaltic magma to erupt, issuing basaltic lavas to the surface (this “hotspot” has moved eastward and is now located at the Yellowstone Hotspot in Wyoming). In total, four primary groups of basalt formed, termed the Imnaha, Grand Ronde, Wanapum and Saddle Mountain basalts, in stratigraphic order from oldest to youngest (Figure 5.2). The flood lavas poured from a few thousand dikes (fissures), some nearly a kilometer long, in a mountainous terrain stretching from Weiser, Idaho to Spokane, Washington (Figure 5.5; Taubeneck, 1970).

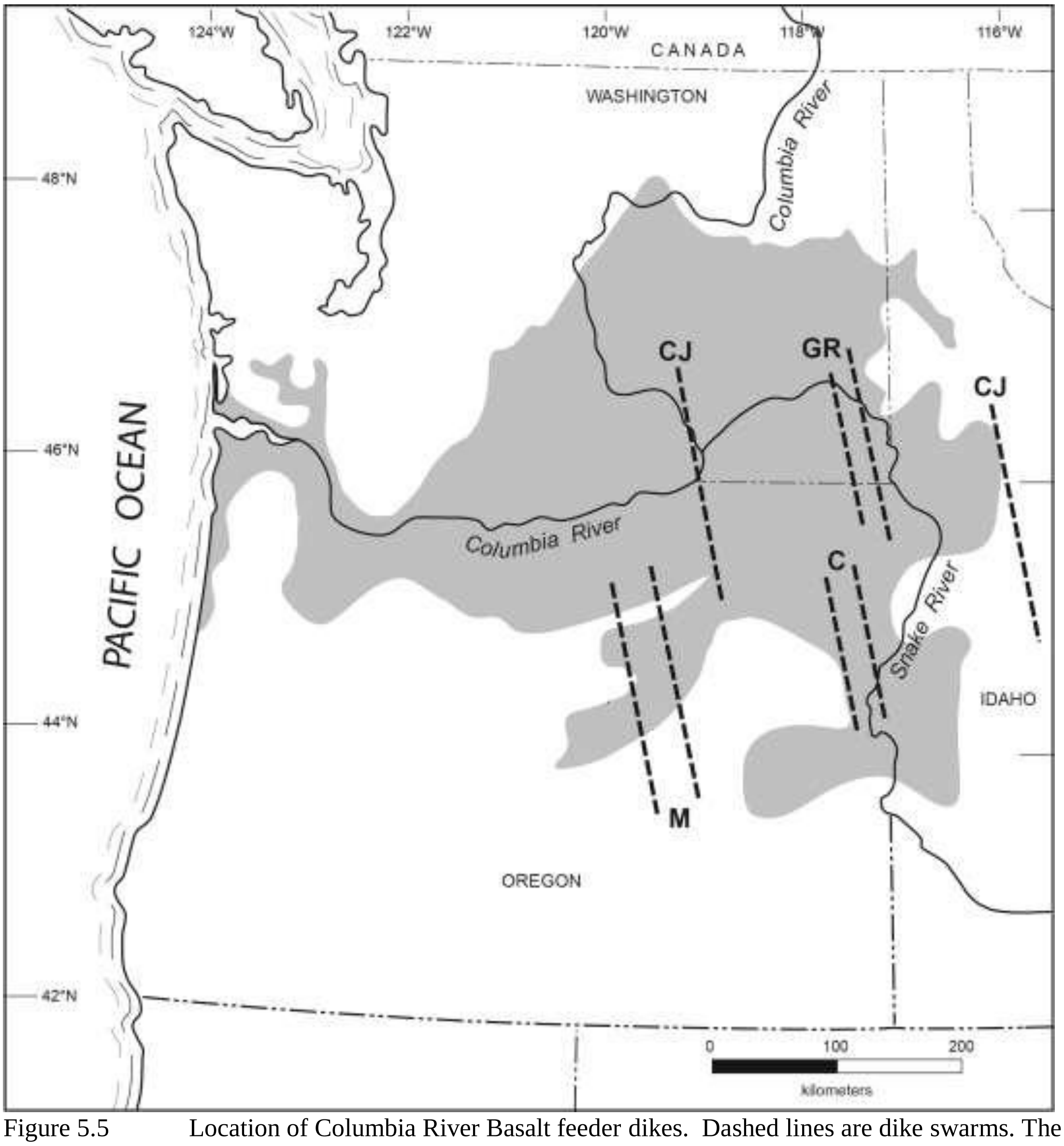


Figure 5.5 Location of Columbia River Basalt feeder dikes. Dashed lines are dike swarms. The Chief Joseph dike swarm (CJ) fed flows in the Imhaha, Grande Ronde, and Wanapum Formations and Saddle Mountains Basalt. The Grande Ronde (GR) and Cornucopia (C) dike swarms. The Monument Dike Swarm (M) was the vent for the Picture Gorge Basalt. (after Hooper 1987).

Among these Formations, the greatest volume of basalt was deposited by the Grande Ronde (GR) fissures, which continued erupting periodically for more than 420,000 years extruding one of the largest volume eruptions of flood lavas on earth (Tolan and others, 1989), at least in Cenozoic time. These middle Miocene Grande Ronde Basalt lavas flowed from the Blue Mountains filling canyons of the ancestral Salmon, Clearwater and Snake Rivers. The basalt floods moved in all directions away from the dikes but especially towards the west where they flowed to the Pacific Ocean. The Grand Ronde lavas flooded down the Snake River trench to the Columbia River, filling and covering the Columbia Basin with a thickness between one to three kilometers of basalt sheet flows (Reidel and others 1989a). As many as 300 of these sheets erupted from more than 2000 fissures in the Blue Mountains area of the central Columbia Plateau. Stretching 400 kilometers towards the west, at least 100 sheets combined to invade surface sediments across the Columbia basin, creating a gentle westerly slope to the Pacific Ocean (Reidel and others 1989a).

As the Columbia Basin filled, sediments of the lower Ellensburg Formation, which comprised its surface, subsided to accommodate between 1 to 3 kilometers of Grande Ronde Basalt. This flood filled the Pasco Basin with many sheets spreading out towards the west (Riedel et al. 1989b). Thirty or more basalt sheets flowed towards the west to the Yakima Fold belt and to the north into the Quincy Basin.

Dike swarms converged in the Eastern portion of the Columbia Plateau at the eastern margin of the Pasco Basin. Although as many as 300 flows may have erupted together, the flows combined and mixed, ultimately coalescing into approximately 20 sheet flows (Reidel, 2004). In the Beezley Hills area the uppermost flow of the Grand Ronde basalt is termed the Sentinel Bluffs Member, which includes between 5-10 flows (Swanson et al. 1979).

**History of Columbia River Basalt Studies**

The pioneering studies that developed a basic stratigraphic framework for the Columbia River Basalt Group that could be correlated and mapped over geographically large areas were conducted by Mackin (1947, 1961), and Waters (1961) in the central Columbia Plateau of eastern Washington. At the time of this early mapping it was generally thought that the basalts erupted from local centers and coalesced into a package of about 1 km (3,000 feet).

In the Columbia Basin, Grolier and Bingham (1971, 1978) first mapped and used the basalts to unravel the local geologic history. Bentley (1977) first mapped the Columbia River Basalts from the Pasco Basin across the Yakima Fold belt. The ensuing reconnaissance mapping of the Columbia River Basalts, employing traditional field mapping methods coupled with chemical characterization and paleomagnetic polarity demonstrated that mappable units could be uniquely defined throughout the region where the CRBG is present in Washington, Oregon, and Idaho (Swanson et al., 1979a, 1979b, 1980, 1981; Bentley et al., 1979, 1980, 1983, 1989; Anderson, 1989, Reidel 1988, Reidel and others 1989).

**Regional Stratigraphy**

Flows of the Imnaha Basalt, the oldest belonging to the Columbia River Basalt Group, are found in eastern Washington and Oregon and western Idaho. Overlying the Imnaha, the Grande Ronde Basalt comprises about 80% of the basalts by volume and covers most of the area where they are found. Flows of the less voluminous, but widely distributed Wanapum Basalt overlie the Grande Ronde Basalt across the Columbia Basin. Few flows of the Saddle Mountains Basalt are distributed as widely, but a single flow, the Pomona Member, reached the Pacific Ocean, and it crops out along the lower Columbia River. The number, extent, and thickness of flows vary depending on many factors, including proximity to and volume of the lava that erupted, lava viscosity, cooling process, erosion, and the paleogeography over which the lava flowed. The Beezley hills, source of the chalcedonies of interest, include only basalt flows of the Wanapum and Grande Ronde Basalts. For this reason, the remainder of the discussion will focus solely on these two flow groups.

**Local Basalt Stratigraphy**

The Bedrock underlying the Beezley Hills is composed of multiple basalt flows with sediment interbeds containing the chalcedony which is the focus of this study. Within the Study area, the Columbia River Basalt Group from youngest to oldest consists of three Wanapum Basalt units, the Frenchman Springs, Roza and Priest Rapids members, and one Grande Ronde Basalt unit, the Sentinel Gap member. Figure 5.6 displays an idealized section of the basalt flows and sedimentary interbeds exposed in the Beezley hills vicinity with pertinent field characteristics, Table 5. 1 describes their stratigraphic detail.

Approximately one kilometer thickness of Grand Ronde basalt lies beneath the surface of the Beezley hills. The Ephrata area, within the core of the Beezely anticline, includes two exposed upper Sentinel Bluffs flows. Silicified sediment is caught between these flows; this is the source of the Beezley chalcedonies.

**CRBG interbedded sediments**

In order for silicified/petrified wood and bog to undergo the process of transformation from organic to silicic, it must first end up in a depositional scenario that is conducive for preservation. The nature of deposition (i.e. mud flow, lahar etc.) is irrelevant, the key is that its burial creates an anaerobic environment and the organic material is preserved. Over time, silica in the encasing sediment, coupled with mobile silica in groundwater, replaces the organic material, creating a silica-based replacement of petrified bog and wood into the chalcedonies (Prakash and Barghoorn 1962).

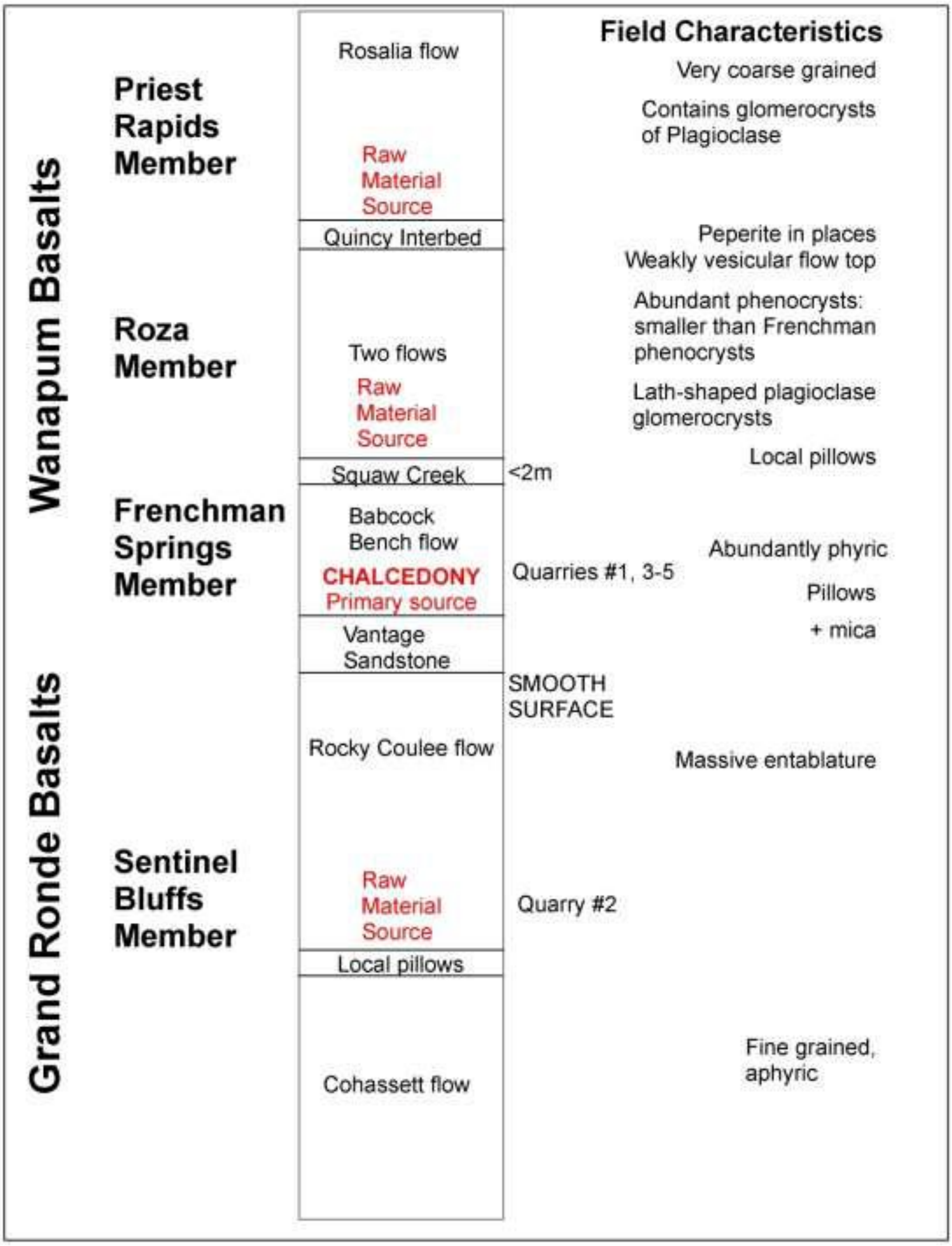


Figure 5.6 Local stratigraphic column with field characteristics and stratigraphic location of Quarries 1-5

Table 5. 1 Stratigraphic Units, Beezley Hills Basalt (after Grolier and Bingham 1971)

**Wanapum Stratigraphy**

The Wanapum Basalt Formation is divided into the Priest Rapids (Tp), Roza (Tr), and Frenchman Springs (Tf) Members. Locally, the Ellensburg Formation is represented by the Quincy Interbed within the Wanapum Formation and the Vantage Member that overlies the Grand Ronde Basalt Formations. The Priest Rapids Basalt Member (Tp) is the uppermost basaltic flow of the Wanapum Basalt Formation. The Priest Rapids Member consists of grayish black, medium to coarse-grained, dense to vesicular basalt. The rock weathers to reddish-brown, and often has large columns and platy partings in its basal flows, with a pillow-palagonite containing petrified wood at its base (Grolier and Bingham 1971, 1978). The unit consists of two flows and is about 60 meters thick. The Priest Rapids Basalt is the most extensive basalt flow unit in the Beezley study area. The Quincy Member (Tq) is a 10 meter thick sedimentary unit of diatomite between the Priest Rapids and Roza Basalt Members.

Roza Basalt (Tr)

The Roza Member (Trz) is near the middle of the Wanapum Basalt Formation. The Roza Basalt is dark blue-gray and medium- to coarse-grained, porphyritic (1 centimeter plagioclase phenocrysts), and weathers to deep reddish-brown. The Roza Basalt has large columnar joints throughout that generally range from 5 to 10 feet across. The columns also have platy parting planes mostly normal to the axis of columns (Grolier and Bingham 1971 and 1978). The unit consists of one or two flows and is about 30 meters thick in the study area.

Frenchman Springs Basalt (Tf)

The Frenchman Springs Member (Tf) is the lowest flow in the Wanapum Basalt Formation. The Frenchman Springs Basalt is dark gray, fine to medium grained, and porphyritic (10 to 25 millimeter plagioclase phenogrysts). The upper contact is marked by cherty concretions and sandy clay, and the basal part of the flows have thin (less than 1meter thick) pillow-palagonite zones containing petrified logs. The unit consists of one or two flows and is about 30 meters thick in the study area.

Vantage Sandstone (Tv)

The Vantage Member (Tv) is a sedimentary unit between the Wanapum and Grande Ronde Formations. The unit consists of light colored, weakly cemented tuffaceous sandstone and siltstone, and ranges between 1 to 10 meters thick. The Vantage Sandstone is generally concealed by talus that has fallen from overlying flows onto lower basaltic benches, or by loess that has accumulated across its exposed surface.

**Grande Ronde Stratigraphy**

This unit is mapped in the Beezley Hills area as Undifferentiated (TgrN2). The Grande Ronde Formation is the most aerially extensive unit of the Columbia River Basalt Group and it underlies the entire study area to depths of at least several hundred feet. The Grand Ronde basalt is black or dark gray, fine-grained to aphanitic, and often displays hackly jointing. Columns are commonly smaller than in the overlying Frenchman Springs, Roza, and Priest Rapids Members, and the unit includes thick zones of pillows and palagonite (Grolier and Bingham 1971 and 1978). The Grande Ronde consists of multiple flows with only rare sedimentary interbeds, the interbeds in the Sentinel Bluffs member in the Beezley lithic source area are relative anomaly.

The nature and composition of sediments found interbedded with the Columbia River Basalt Group vary greatly, ranging from epiclastic to volcaniclastic in origin. Within the central to western Columbia Plateau region, sedimentary interbeds between basalt flows are assigned to the Ellensburg Formation (Swanson et al., 1979a; Fecht et al., 1987; USDOE, 1988; Smith et al., 1989). These sediments were deposited by Miocene alluvial systems and as air-fall and reworked tephras from Miocene volcanoes active in the Cascade Range and the northern Basin and Range. Events controlling the deposition of Ellensburg sedimentary interbeds include: (1) emplacement of CRBG flows and their impact on paleodrainage systems, (2) synvolcanic sedimentation from

Cascade mountain sources, and (3) local and regional tectonism (uplift and subsidence) (Fecht et al., 1987; Smith, 1988; Smith et al., 1989). Individual sediment interbeds within the Ellensburg Formation range from less than 3 feet thick to more than 100 feet thick and can be traced laterally over large areas (Mackin, 1961; Schmincke, 1964; Bentley, 1977; Grolier and Bingham, 1978; Swanson et al., 1979a; Fecht et al., 1987; Smith, 1988; DOE, 1988; Smith et al., 1989). The location of Beezley chalcedonies and other regional lithic sources are correlated with Ellensburg sediments.

After about 15.6 Ma the last and uppermost Grand Ronde flows ended. During the broad periods of time between flows of basalt the Columbia River flooded the central Columbia Plateau, depositing fine-grained overbank sediments across a broad floodplain with the main river channel some distance to the west. In this low energy sedimentary basin, the middle Ellensburg Formation was deposited (Bentley, 1977; Waitt, 1979). The interbeds have informal names, depending on their stratigraphic position. Interbedded sediments between Grande Ronde Basalt and the overlying lowest Wanapum Basalt flow are called "Vantage sandstone". The sediment between the lowest Wanapum Basalt Frenchman Springs and Roza members is termed the Squaw Creek interbed. Finally, the interbed between the Roza and Priest Rapids members is the "Quincy" interbed. These sediments are usually thin (<1 to 7 meters) composed of low energy sands, silts and clays. They are seldom exposed in outcrop on the landscape, rather, they often form zones of enhanced vegetation growth due to relatively higher volume of water that is able to flow through the interbed to the exposed surface. In the Beezley source area, the Vantage sediment now overlies the Sentinel Bluffs flows and is the most likely source for the lithic raw materials at Quarry sites 1, 3, 4 and 5 (Figure 5.6).

**Basalt Rafting**

A fundamental axiom in the field of geology is Steno's law of superposition, which states that sedimentary layers are deposited sequentially in time, with the oldest material on the bottom and the youngest on the top (Steno 1669). Surface geologic materials will only deviate from this in the most unusual circumstances; flood basalts provide just such a scenario for unusual behavior. As a basalt flow moves across the surface of earth it will consume and/or bury material in its path, unless it encounters a sedimentary basin. Because of the differential densities involved, the basalt flow will intrude the sediment, flow along its basin floor, lifting the lighter, relatively buoyant sediment body to its surface (Byerly and Swanson, 1978; Swanson and Wright, 1978; Beeson et al., 1979, 1989; Stoffel, 1984). This heavy basalt often elevated sediments to their flow tops and carried these "rafts" as a cover above the sheets of basalt. Thousands of years later with the arrival of the next basalt sheet flow, it elevated, engulfed and carried the sediment debris package upward again as a surface package. The same principal is true of the internal architecture of the lava flow itself. The top of a flow may have formed first and the later magma invaded underneath the initial flow. This process is termed "rafting", "invasive" or "inflated" flow.

Traditionally, fieldwork in basalts of the Columbia Plateau assumed three factors that have recently changed. These factors, which have direct bearing on the origin of flakable lithic raw material in the basalt flows, are: 1. Duration of basalt flows, 2. Rate of emplacement, and 3. Mode of emplacement. Over the last fifty years of regional fieldwork geologists have assumed that basalt flows spread westward from the source dikes, down a gently inclined surface to cover thin sediments deposited on a flat basalt flow surface (Riedel and Tolan 1992). It is now also clear that the basalt flows likely spread westward from the source areas slowly, under an inflated surface crust. This requires that basalt flow units are emplaced relatively slowly, inflating an earlier injected basal crust from the base of the initial portion of the basalt flow (Byerly and Swason, 1967; Hon 1994; Self et al. 1996). The significance of this new concept in flood basalt deposition to our understanding of the Beezley chalcedonies relates to the issue of how trees and organic matter are incorporated into the basalt flows, ultimately to be preserved and silicified. Ellensburg Formation sediments, including the post Wanapum sand-and-gravel-bar deposits from the ancestral Columbia River and related interbeds deposited in shallow lakes formed by temporary damming of the Columbia River (Riedel and Tolan 1992) were the parent material for the chalcedonies. Rafting of these sediments and organic matter that would later be silicified in void space within the basalts occurred by this process of inflation.

**Nature and location of the quarries**

The high quality Beezley chalcedonies appear to have formed in three different environments and are located at as many stratigraphic horizons in the local basalt sequence. Five identified prehistoric quarries are shown on Figure 5.7. At each quarry chalcedony has been identified from fragments of agate, opal, and flaking debris scattered on the ground surface. Figure 5.8 shows the location of the quarry #2 relative to the basalt flows in the stratigraphic section. At any outcrop or along any bench, each of the basalt units could contain pods of agate. Each of these quarries occur down slope from basalt flows that are known to contain petrified wood stumps, pods of bog in chert, logs, pods of silicified sediment, or pods of opal.

The known quarry sites are found just above the top of the Vantage Member, within the lower pillow basalt zone of the Frenchman Springs Member of Wanapum Basalt (Figure 5.2 and Figure 5.6). This pillow basalt is an abundantly phyric (with visible mineral crystals) basalt flow which is locally named the Babcock Bench flow (Mackin, 1961; Grolier and Bingham, 1971; Beeson et al., 1985). The exposure area of the Babcock Bench flow is shown on the geologic maps (Figure 5.8 and Figure 5.9) of the Beezeley Hills anticline. The geologic map shows the approximate location of this basalt flow with the associated Vantage Member and where natural outcrops of chalcedony and the prehistoric quarries are exposed. A key relationship in the basalt stratigraphy, as it relates to quarry locations is that the majority of recorded quarries exist near this contact.


Figure 5.7 Location of five Beezley quarry sites. TWfsbb is Frenchman Springs Babcock Bench flow; TGRsb is Grand Ronde flow. Generalized stratigraphy is based on previous work by Le Fervre, (1967); Grolier and Bingham (1971, 1978) and Swanson et al. (1979a), who identified the local basalt units and their distributions. The basalt contacts were mapped in the field for this dissertation project, and transferred to the air photo.

The materials in contact with the basalt flow front (resting on the original sediment, dead wood and organic matter surface) were likely rafted upward into the overlying basalt. The advancing flow fronts in the western Columbia Plateau most often invaded the sediment and elevated much of the lower density materials to the top of the basalt flow (Self et al., 1996). Here, the elevated material became a part of the sediment at the top of the flow, known locally as the Squaw Creek Member. Petrified siliceous woody materials are common at the base of the Wanpum Basalt thoughout much of the

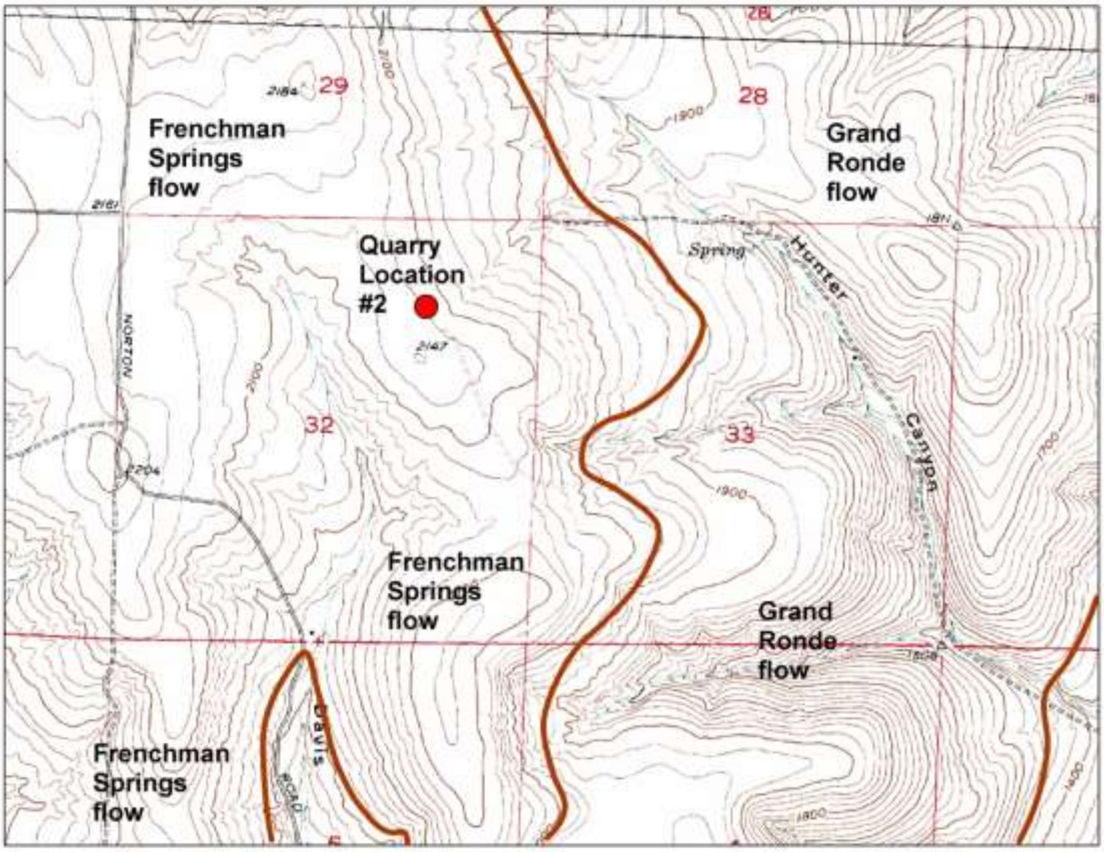


Figure 5.8 Location of quarry #2 in relationship to the Frenchman Springs and Grand Ronde flows

western Columbia Plateau, a horizon made famous by the Ginkgo Petrified Forest to the south and west of the Beezley Hills (Beck, 1941, 1945; Bentley, 1977; Tolan et al. 1992; Orsen and Reidel, 2003). In prehistory, Beezley chalcedony would have been identified by colonizers on the ground surface as float, or scattered on the small bench that is commonly formed at the top of the more resistant Grande Ronde Basalt (just below the Vantage sediment in this area).

A second stratigraphic level and environment where Beezley chalcedonies (Quarry #1) are known to occur is approximately 100 meters lower in the basalt section described above, near the flow top of a Sentinel Bluffs Member of Grande Ronde Basalt (Figure 5.9; Reidel, 2004). The lithic raw material appears in pods of silicified fine grained sediment (Quarry #2) caught in the top of the Cohassett flow (Sentinel Bluffs Member of Grande Ronde Basalt). It is part of an invasive flow that is rafted sediment (Byerly and Swanson, 1976) from a lower stratigraphic level in the Grand Ronde Basalt. It is postulated that much of the interlayered sediment in the Grande Ronde Basalt is elevated multiple times (Self et al. 1996). It is also possible that the sediment and wood that are now petrified in the exposed interbeds were part of a package of fine-grained lower Ellensburg sediments (Newman 1970) deposited originally in Oliogocene or lower Miocene time, between 26-17Ma. These Oligocene/Miocene sediments underlie the Grande Ronde Basalt across the Columbia Basin (Bentley, 1977, 1980).

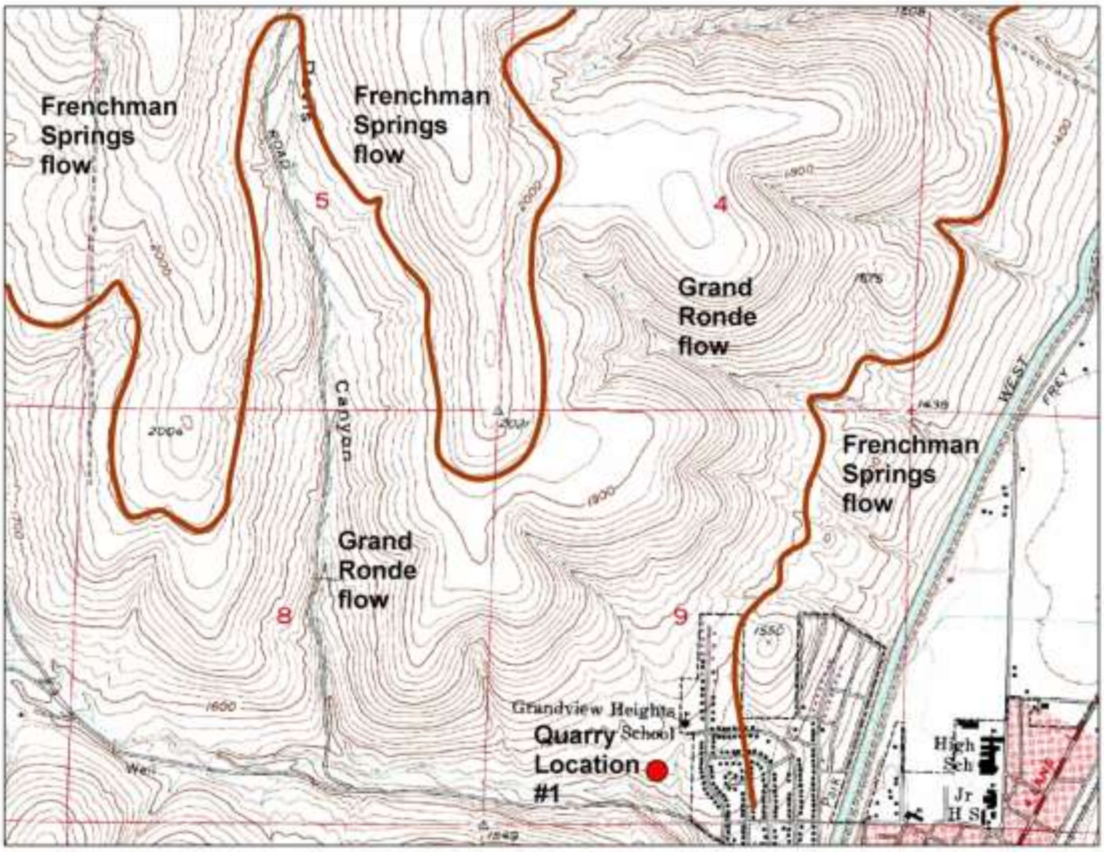


Figure 5.9 Location of quarry #1 in relation to Grand Ronde and Frenchman Springs flows

In addition to siliceous sedimentary pods at quarry #2, this interbed/pillow zone may also have associated petrified wood or bog, but these are not present in the exposures that I have seen. It is conceivable that some or all of the petrified material that formed during Oligocene times was rafted to middle Miocene basalt levels by many different Grand Ronde eruptions.

A third stratigraphic level and environment where chalcedonies are known to occur is approximately 60 to 80 meters higher in the basalt section described above-- near the flow top of the Babcock Bench flow just overlying the Squaw Creek Member (Mackin, 1961; Grolier and Bingham, 1971; Bentley, 1977: Beeson et al., 1985) within the Roza Member of the Wanapum Basalt (Figure 5.2). This material is likely in pods of petrified wood and bog, and in silicified, fine-grained sediment caught in the basal portion of the Roza flow. Although it is possible that the woody and organic materials that are now petrified grew there and became silicified *in situ*, it is more likely that the lithic raw material is part of flow-top sediment rafted up-section from the Vantage sediment (Bentley, 1977).

Orsen and Reidel, (2003) summarize occurrences of petrified wood in the basalt and every example of agate they record is in the basal or lower parts of flows. However, if Tolan et al. (1997) and Beck (1945) are correct about the origin of the Ginkgo Petrified Forest, in particular that wood was concentrated in a lahar layer debris flow or in a lake/bog sediment before they were buried by the basalt, then it is possible petrified wood occurs within the sediment but it appears to be rare.

## Conclusion

Although siliceous materials are present in several levels of the Beezley stratigraphic section, the most likely source for Beezely chalcedonies is in the Babcock Bench flow within the Frenchman Springs Member at the base of the Wanapum basalts, where a thin pillow palagonite is present in the section. This is essentially the Ginkgo Petrified wood horizon which Orsen and Reidel (2003) define as the forest at the top of the Vantage member and the Base of the Ginkgo flow. The thickness of the Vantage interbed varies from less than 1 meter to 7 meters in the Beezley Hills area (Lefebvre, 1970, Grolier and Bingham, 1971, 1979).

Practical application of the new geosol information presented in this dissertation may assist in understanding lithic quarry delineation. In the central Columbia Plateau, Flenniken and Ozbun (1993) attempted to associate a variety of indicators (recent to historic items mixed in sediment, mechanical disturbance, lack of vegetation etc.) to delineate ancient vs. recent quarry excavation features. Bailey (2006) reports that a Central Washington University field school attempted to apply these associations, but they ultimately failed. By applying the understanding of the regional geosols presented in Chapter 4, it may be relatively simple to understand whether or not disturbed ground in the quarry area is from recent (void of pedogenic development) or prehistoric (displaying a range of pedogenic development).

## The West Bar cache

To illustrate the importance of high quality tool stone like the Beezley chalcedonies, I've added the following section related to a cache of stone tools made entirely from Beezley stone. The Richey-Roberts cache demonstrated that the Beezley stone source was important during the colonizer period. This is the first description of another cache of stone tools with Clovis affinities, made on Beezley stone. The cache is from a relatively non-specific location on West Bar, a megaflood feature south of Trinidad, Washington State, just 15 miles southeast of the Richey-Roberts site.

## Clovis caching

Paleolithic stone and bone tool caches, collections of artifacts that are intentionally left behind, are known from both Old and New world archaeological sites. The practice of intentionally caching groups of artifacts appears to have roots in Mesolithic Old world contexts (Levy 1982). Epipaleolithic caches are known from Israel and France, and the Upper Solutrean archaeological culture cached lithic material during Solutrean times (Stanford and Bradley 2000). In the Paleolithic of North America, just more than 20 Clovis caches are known in the literature, although the majority are not comprehensively reported (Table 5.2). Among these, three are known from the general vicinity of the Pacific Northwestern states, they are Anzick in Montana, Simon in Idaho and Richey-Roberts in Washington State (Butler and Fitzwater 1965; Gramly 1991; Lahren and Bonnichsen (1974) Clovis caches are especially valuable from an analytical perspective because they often document stages of the lithic reduction technology.

Table 5.2 Widely known Clovis caches

| | Cache | Reference Citation |
|---|---|---|
| 1. | Anadarko | Hammatt 1970; also known as McKee |
| 2. | Anzick | Jones and Bonnichsen 1994; Taylor 1969; Wilke at al. 1991 |
| 3. | Busse | Hoffman 1995 |
| 4. | de Graffenried | Collins et al. 2007 |
| 5. | Crook County | Byrd 1997; Tankersley 1998 |
| 6. | Carlisle | Gill at: uiowa.edu/~osa/Silos/Carlisle_Cache.html |
| 7. | Drake | Stanford and Jodry 1988 |
| 8. | Fenn | Frison and Bradley 1999 |
| 9. | Franey | Grange 1964 |
| 10. | Green | Collins 1999; Green 1963 |
| 11. | Kevin Davis | Collins 1999; Kay 1999; Young and Collins 1989 |
| 12. | Mahaffee | At present, only reported in the U.S. National media |
| 13. | McKinnis | unreported in the literature, but found at: lithiccastinglab.com |
| 14. | Pelland | Stoltman 1971 |
| 15. | Richey-Roberts | Gramly 1992 |
| 16. | Rummells-Maske | Morrow and Morrow 2002 |
| 17. | Sailor-Helton | Mallouf 1994 |
| 18. | Simon | Woods and Titmus 1985 |
| 19. | Watts | Kilby 2008 |
| 20. | West Bank | Montgomery and Dickenson 1992 |

The first reported discovery of a Clovis cache occurred in 1961 during grading operations at what is now the Simon site on Big Camas Prairie, near Fairfield, Idaho (Butler 1963; Butler and Fitzwater 1965; Woods and Titmus 1985). Twenty-nine ocher-stained lithic artifacts were discovered including five Clovis points and 24 bifaces, two made on quartz crystal, in total, representing stages of Clovis flaked-stone reduction technology from large bifacial flake cores to smaller bifaces, and finished Clovis points.

Construction workers uncovered the Anzick Cache near Wilsal, Montana, in 1968 (Frison and Bradley 1999). This cache consisted of more than 100 artifacts (Clovis points and bifaces), like the Simon cache, they were covered in ochre. The artifacts were reported to be found in association with human remains, but radiocarbon dating has demonstrated an anomalously recent age for the remains, widely out of the range of Clovis culture (Stafford 1994). The Richey-Roberts Clovis cache is located in central Washington State. It is technologically similar to the Anzick Cache and the Simon Cache (Frison and Bradley 1999). Details of the Richey-Roberts cache are found in Chapters 2 and 6.

### Background and History of the West Bar cache

I first learned of the West Bar cache in 1998. The cache was on display in the Cashmere Historic Society Museum in Cashmere, Washington State. Russell Congdon, a physician and antiquarian whose collection is housed at the museum, told me the name of the person who collected the cache and a brief background of its location. Although I know the name and contact information of the original collector, all attempts to speak with him about the find have been denied; all information relayed here is based on second-hand information from Russell Congdon, who learned details of the find from the original collector.

According to Congdon the cache was excavated in the early 1990s. It was partially exposed on the surface of the eastern shore of West Bar, an Upper Pleistocene megaflood landform in the Columbia River trench (Figure 5.10). According to Congdon, portions of the cache were partially exposed on the ground surface of the point bar. The collector surface-collected the exposed artifacts at the site, marked it, and then left


Figure 5.10 Approximate location of the West Bar cache find-spot

to bring back excavation tools. On his return he hastily excavated the cache and a short time later it was brought to Congdon for examination. Congdon, the son of the original founder of the Columbia River Archaeological Society (introduced in Chapter 1) and the person who was the first to distinguish the Richey-Roberts cache as Clovis, recognized the potential importance of the West Bar cache, and immediately acquired it for the Cashmere museum. At this point in time, no other information is available regarding the details of the find.

**The West Bar Cache described**

The West Bar cache is comprised of 30 objects; portions of 11 bifaces, 2 of which are biface cores, 15 flake blanks, 3 tabular cores and one tabular blank (Appendix 3). The best information indicates the bifaces were found together, as an isolated collection on West Bar near Trinidad, Washington. They were originally catalogued through the auspices of the Cashmere Historic Society Museum under accession numbers CRC1 through CRC30 and are housed at their facilities in Cashmere, Washington State. Nine of the specimens retained cortex, although in all cases except one, it was minimal.

The cache represents a small subset of the reduction stages of Clovis lithic technology from large prepared bifacial cores of Beezley chalcedony to bifacial (likely Clovis point) blanks. Formal tool definitions presented below are drawn largely from Root and Fergeson (2003), however, they are common to the primary cache and Clovis reduction sequence literature (Collins et al. 2007; Frison and Bradley 1999; Wilke et al. 1991; Gramly 1992). A limited variety of artifact classes are represented in the West Bar Cache, they include flake blanks, tabular and bifacial blanks, and tabular and bifacial cores (Table 5.3).

Two aspects of the Clovis reduction sequence that are important with regard to the West Bar cache is that of “overshot” flaking and end-thinning. Collins and Hemmings (2005) described a set of standards for Clovis biface reduction based on extensive work at the Gault site in Texas. In their scheme, Clovis points were made from reduced cores or from very large flakes, similar to those in the West Bar cache. Clovis knappers applied overshot (outré passé) flaking which created broad, often distally-expanding flake removals that would travel across the face of the artifact, sometimes removing the opposite biface margin. In a separate report, Collins et al. (2007) report that the larger bifaces and performs generally have three or four such removals, covering the majority of the tool face. Clovis biface end thinning, which removes basal flakes in anticipation of fluting, are often seen relatively early on Clovis cores and performs. The West Bar cache displays clear aspects of Clovis biface reduction, as described below.

**Tabular and Flake Blanks**

This category includes both modified and unmodified stone. Tabular blanks are made on unmodified natural stone; flake blank production is by direct percussion with no other manufacturing input beyond production of the blank. Unmodified flakes that are inferred to be blanks for the manufacture of other tool types are also placed in this class. The West Bar cache contains 16 tabular or flake blanks, 8 of which, although small, are suitably sized for reshaping as fluted points (#s 6, 10, 12, 14, 15, 16, 20 and 28; Stage 1 of Callahan 1979). Three of these specimens, #s 5, 14 and 15 exhibit possible marginal use wear as tools. All but one of these are made on flakes, #28 appears to be a naturally-occurring tabular blank with remnant cortex. Preparation for reduction into tools is evident on some of the specimens; platform preparation for thinning the flake blank is evident on CRC6 and CRC8 (Figure 5.11) has been end-thinned to normalize or remove the tri-angular cross-section. CRC12 and CRC16 (Figure 5.12) are both flakes removed from very large bifacial cores. CRC4 is a relatively small, alternate flake struck from a tabular core.

**Tabular Cores**

This category includes platy or thin tabular pieces of raw material that have one or more flake removals from an edge, lacking bifacially flaked edges, although flaking may be multidirectional and may cover all surfaces. Tabular pieces may be naturally occurring, or may also be from thicker, naturally weathered material recovered in outcrop or otherwise at the quarries. Tabular plates are less than 3.5cm thick, and are characterized by non-bifacial percussion; flake removals have either Hertzian or bending initiations. The amount of flaking varies, ranging from removal of a few flakes to nearly complete reduction of cores. The key differentiation between tabular cores and tabular blanks essentially relates to size; tabular blanks are reduced to a point where subsequent reduction for the purpose of creating useful flakes is less than likely.

## Tabular Blanks

Tabular blanks have a quadrilateral cross section; both inner and outer surfaces are flat and are parallel (White et al. 1963). In the West Bar cache this category only includes two artifacts (CRC3 and CRC7). CRC3 is a thin, plate-like piece of raw material that may have been naturally occurring, or it may also be from a thicker, naturally weathered material recovered in outcrop or otherwise at a Beezley quarry (Figure 5.13). The artifact is retouched along a single face of one margin for use as a tool, but it is still large enough to be reduced into any number of tool types. CRC7 is a portion of a very large, thin tabular piece of raw material, without cortex (Figure 5.14). Like so many

Table 5.3 West Bar Cache metric data

| Artifact Classes | Artifact # | Length (cm) | Width (cm) | Thickness (cm) | W/T | Weight (g) |
|---|---|---|---|---|---|---|
| **Flake Blanks** | 2 | 5.15 | 5.13 | 1.26 | N/A | 35.2 |
| | 5 | 5.71 | 2.52 | 1.18 | N/A | 18.1 |
| | 6 | 6.25 | 5.17 | 1.26 | N/A | 44.3 |
| | 8 | 5.07 | 5.47 | 1.60 | N/A | 39.6 |
| | 10 | 5.46 | 7.35 | 1.61 | N/A | 56.5 |
| | 11 | 7.28 | 3.29 | 1.66 | N/A | 31.5 |
| | 12 | 9.58 | 4.97 | 2.27 | N/A | 71.1 |
| | 14 | 5.97 | 7.39 | 1.67 | N/A | 78.2 |
| | 15 | 6.77 | 6.00 | 1.71 | N/A | 56.9 |
| | 16 | 8.56 | 5.26 | 1.93 | N/A | 68.0 |
| | 17 | 6.01 | 5.01 | 1.58 | N/A | 33.0 |
| | 18 | 5.61 | 5.06 | 1.19 | N/A | 27.5 |
| | 20 | 8.65 | 5.55 | 1.49 | N/A | 51.4 |
| | 21 | 7.62 | 4.53 | 1.37 | N/A | 37.9 |
| | 4 | 3.30 | 3.19 | .70 | N/A | 6.7 |
| **Tabular Cores** | 1 | 10.07 | 3.58 | 2.72 | N/A | 86.8 |
| | 22 | 5.85 | 4.82 | 1.84 | N/A | 52.7 |
| | 28 | 13.44 | 6.73 | 3.27 | N/A | 271 |
| **Tabular Blanks** | | | | | | |
| | 3 | 6.91 | 4.23 | 1.56 | N/A | 40.1 |
| | 7 | 6.72 | 3.48 | .97 | 3.59 | 23.7 |
| **Bifacial Cores** | | | | | | |
| | 29 | 20.16 | 7.40 | 4.78 | 1.54 | 865 |
| | 30 | 14.33 | 11.10 | 2.46 | 4.51 | 434.8 |
| **Bifacial Blanks** | | | | | | |
| | 9 | 8.49 | 6.51 | 1.81 | 3.6 | 83.8 |
| | 13 | 6.60 | 6.09 | 1.77 | 3.44 | 61.3 |
| | 19 | 9.28 | 4.16 | 1.64 | 2.54 | 62.8 |
| | 23<br>24 | 9.68<br>9.87 | 5.57<br>5.90 | 2.66<br>2.59 | 2.09<br>2.78 | 122.3<br>144.6 |
| | 25 | 7.92 | 6.14 | 2.21 | 2.79 | 96.3 |
| | 26 | 8.66 | 6.49 | 2.82 | 2.3 | 145.8 |
| | 27 | 8.77 | 5.26 | 1.99 | 2.64 | 90.3 |

paleoindian tools, it displays multiple working aspects. It is a multiple-use tool with a polished and faceted marginal hinge fracture similar to tools from other Paleoindian contexts such as Hanson (Frison and Bradley 1980) and the Lake Ilo Folsom sites (Root et al. 2000). Likewise, one of the fractures is utilized as a burin.

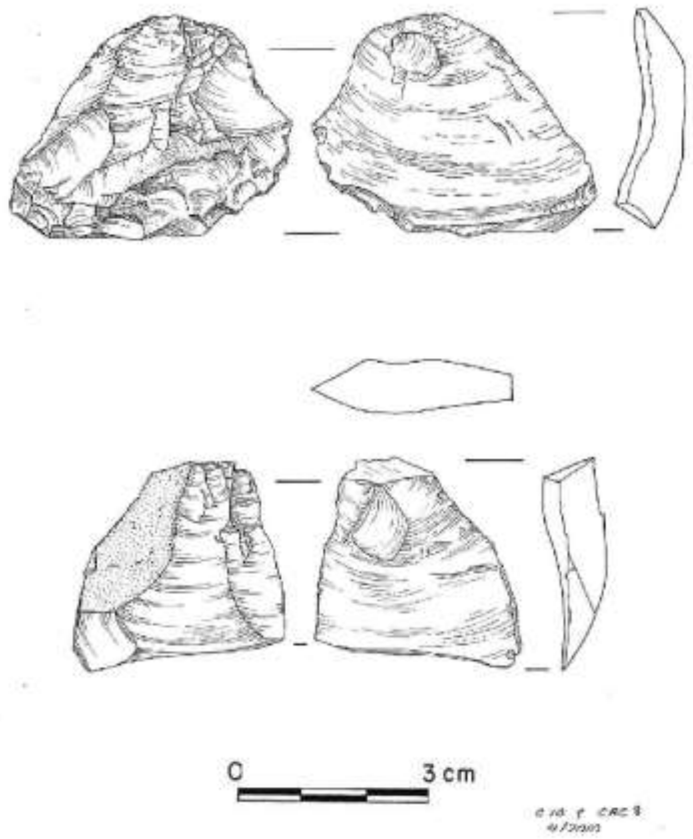


Figure 5.11 CRC8 and 10, flake blanks. CRC8 exhibits end-thinning to remove the tri-angular cross-section.

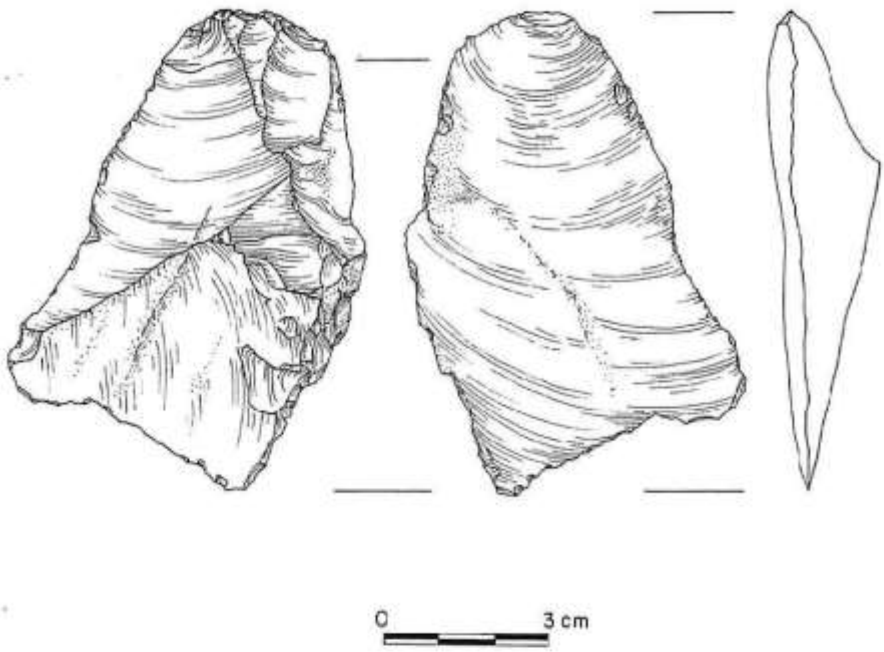

Figure 5.12 CRC 16, a large flake blank struck from a very large bifiacial core

## Bifaces

Summary metrics for West Bar bifaces are presented in Table 5.3. Six of the bifaces are similar in dimension and form suggesting that the intended biface form was a roughly ovate biface of about 9.03 cm in length, 5.6 cm in width, approximately 2.3 cm in thickness, and weighing about 2.5 grams. The entire cache was made on raw material from the Beezley quarries, approximately 40 kilometers from West Bar, which is near Trinidad, Washington. The cache weighed 5,538 grams or about 12 pounds, well within the range of other Clovis caches (Table 5. 4).

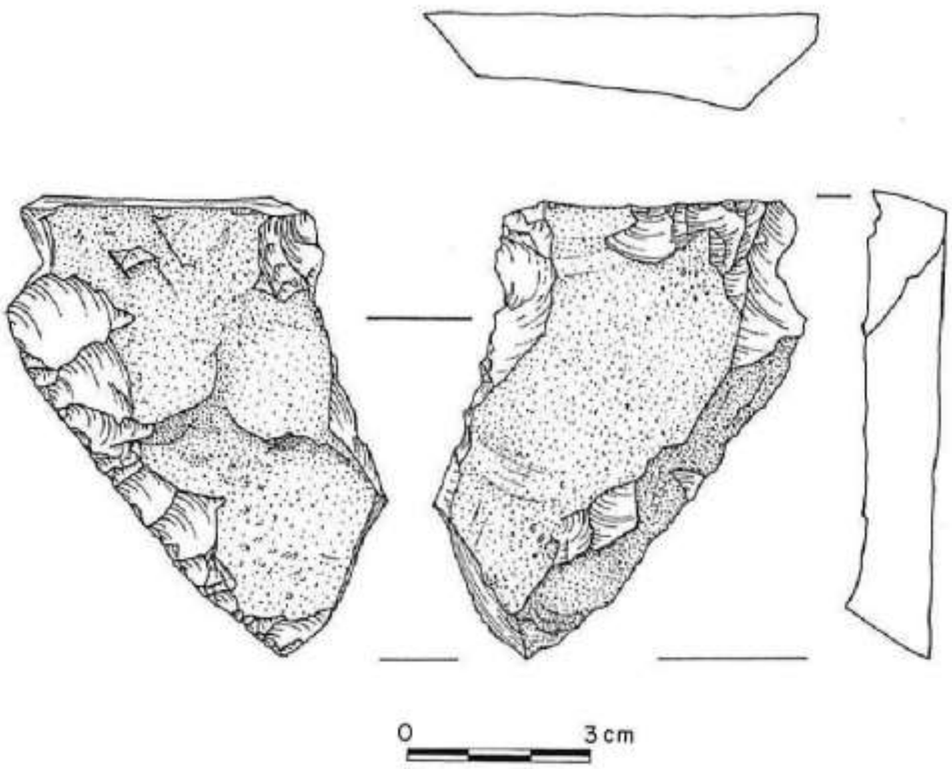


Figure 5.13 CRC3 Tabular blank (utilized)

## Bifacial Cores

Two bifacial cores are present in the West Bar cache. These tools are characterized by the removal of a series of large percussion flakes from bifacial platforms. Flake initiations are Hertzian or bending and were removed from opposite faces to form bifacially flaked artifacts. Many of the flakes are “overshot” style, where the flake progressed across the face of the biface, either removing or nearly removing a portion of the opposite biface margin. Pressure flaking is generally absent, but if present, it isrestricted to platform preparation. Bifacial cores represent a conservative strategy for transporting high quality tool stone into areas afield where sources of similar material

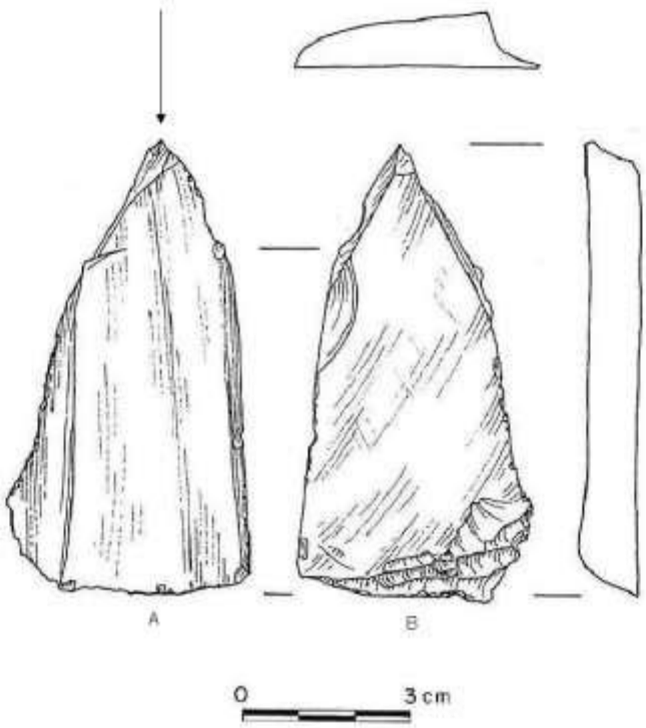


Figure 5.14 CRC7 hinge tool with burination. Polished and faceted hinge is located on the right side of face A, burination is noted by arrow.

are scarce (Kelly and Todd, 1988). Bifacial cores might have served as tools (CRC30 has several utilized margins) but cores also provide the material necessary for Clovis point manufacture (Hoffman, 1992; Wilke et al. 1991). CRC29 is a large, blocky core with unpatterned flake removals. CRC30 (Figure 5.15) is a portion of a classic "platter" biface, strikingly similar to other bifaces in Clovis caches, such as Fenn and Anzick (Frison and Bradley 1999; Wilke et al. 1991), and it also conforms well to the Clovis biface reduction scheme of Collins et al. (2007).

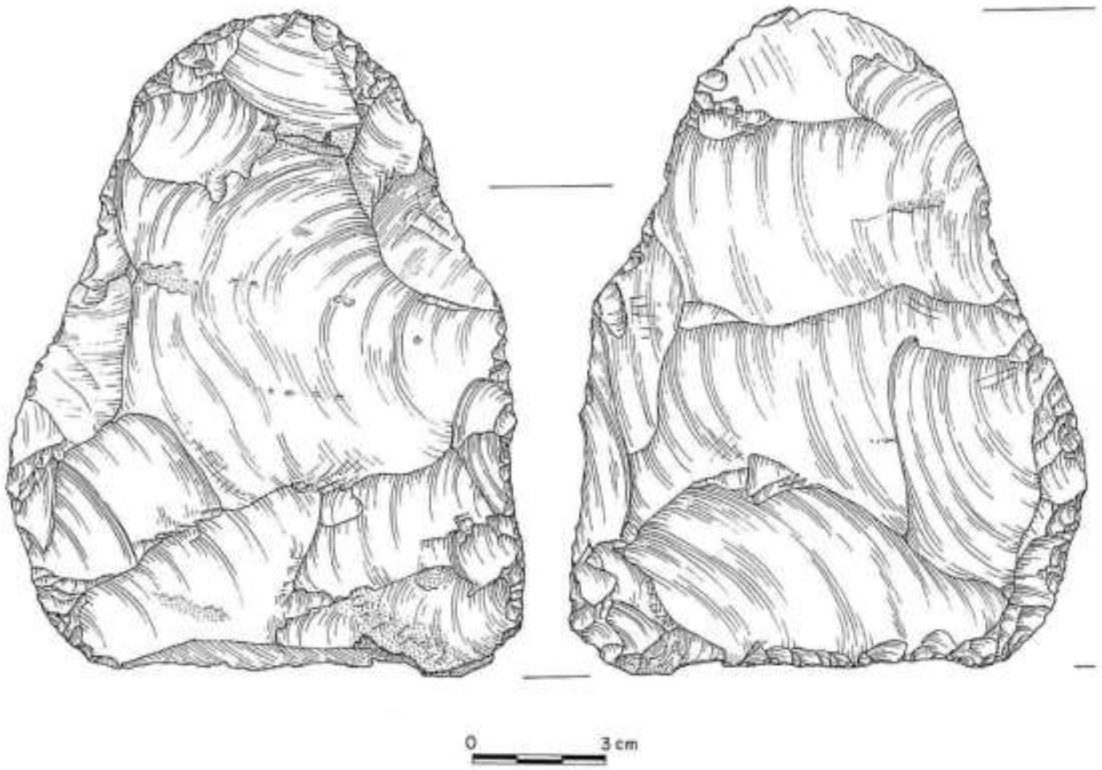


Figure 5.15 CRC30, large, broken bifacial core with overshot biface reduction

## Bifacial blanks

These tools include bifaces that exhibit use damage but no other manufacturing input beyond production of the biface. Blank production is non-bipolar, percussion. Eight bifacial blanks are present in the West Bar cache, CRC#s 9, 13, 19, and #s 23-27). CRC9 and 13 are both retouched for use as a tool and CRC9 has a large bend break that indicates it is part of a larger biface. CRC19 displays a giant overshot flake that removed the majority of the entire face of the biface (Figure 5.16). Bifaces CRC23-27 are strikingly similar to eachother in their dimensions and weight. It is tempting to refer to them as Clovis point blanks (stage 3 of Callahan 1979), except that they are still of sufficient size to reduce into other tool types. Because no finished fluted points are present in the cache, they will be considered here as more generic

CRC19

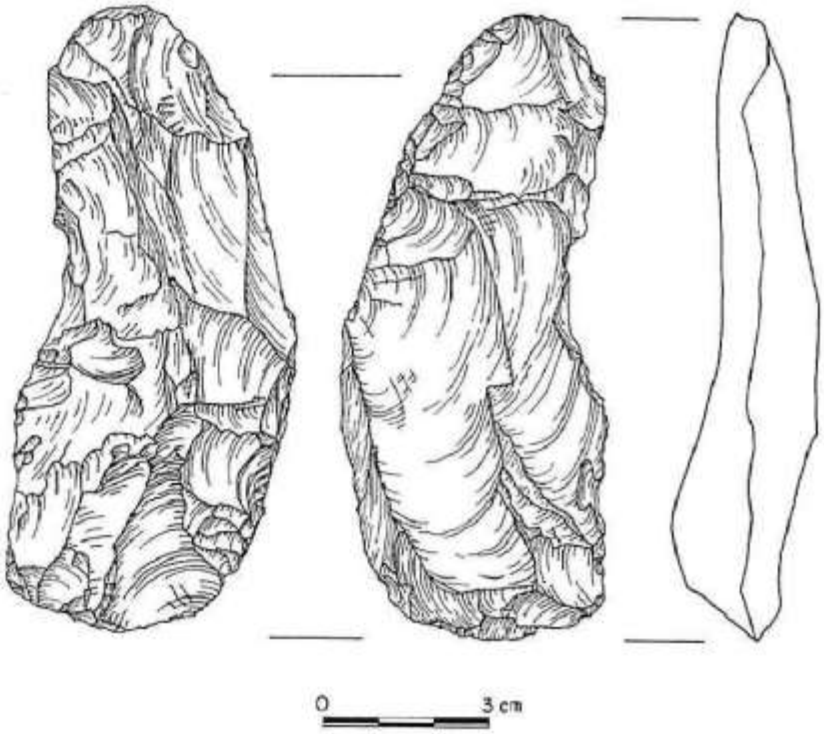


Figure 5.16 CRC19 exhibiting overshot flaking

bifacial blanks. Several of the bifaces have characteristics that are similar to Clovis reduction elsewhere. CRC 23, 24 and 26 each display relatively early stage end-thinning, similar to specimens reported from the Gault Clovis site in Texas and at the Topper site in (Collins et al. 2007; Smallwood 2010). A clear example of end-thinning reduction technology is seen on the base of CRC27, where a low-platform is present in anticipation of driving off the base (Figure 5.17). The same artifact displays exceedingly deliberate isolation and preparation of the biface margin for overshot flaking. This same technological aspect is present on many of the Richey-Roberts bifaces, producing the appearance of a “scalloped” biface margin. Overshot flaking is also present on CRC24, which has two large overshot flake scars.

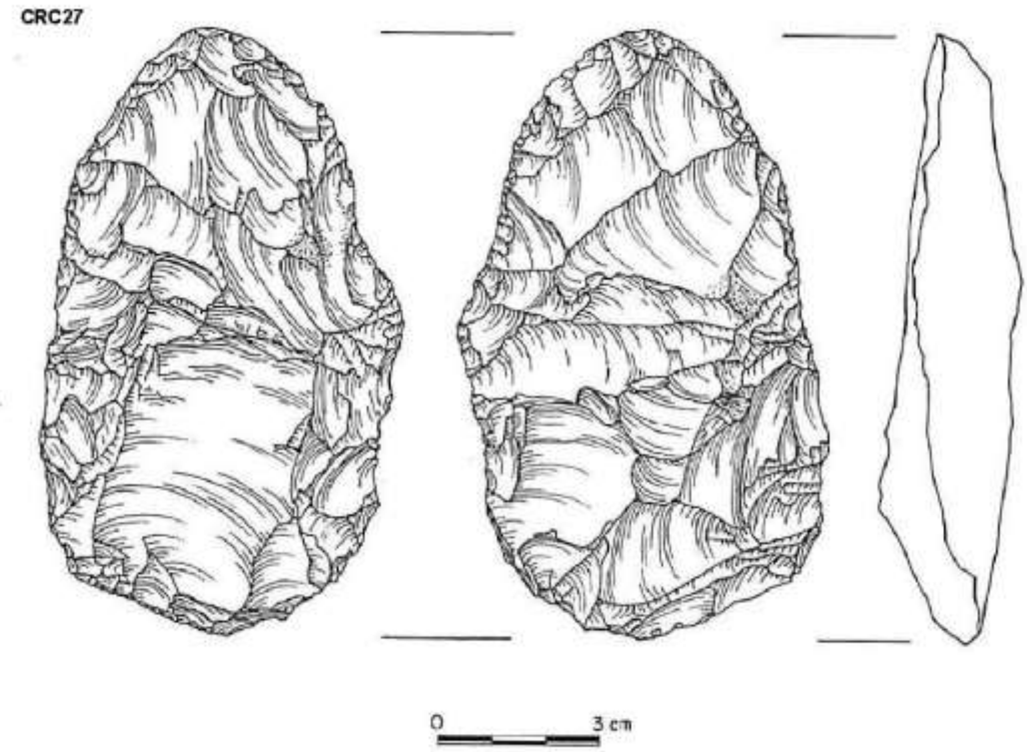


Figure 5.17 CRC27

## Technological Analysis

Analysis of the West Bar cache reveals some common details of Clovis lithic reduction strategies. Most generally, this technology is represented by large flake production. Clovis reduction technology was conservative, focusing on the minimal loss of high-quality stone by producing broad flakes that traveled across the entire face of the artifact (Wilke et al. 1991). The flake cores were reduced by detaching flat, thin flakes, which were normally used as tools, or as flake blanks for further tool manufacture. Of the tools present in the West Bar cache, only a single piece of debitage was recovered (CRC4), an alternate flake that was also ready to be utilized or otherwise transformed into a flake tool. Of course it is unknowable if other debitage was present at the find-spot location until the site is ultimately located.

Technologically, the biface blanks exhibit a generally ovoid outline form with rounded to flat bases that are very consistent with outline forms of bifaces from the Anzick, Fenn, and Simon caches (Frison and Bradley 1999; Wilke et al. 1991; Woods and Titmus 1985).

Longitudinal end-thinning flakes are present on three bifaces (CRC23, 26, 27) but none of the bifaces are fluted. Furthermore, length:width and width:thickness measurements indicate these artifacts form a tight cluster with small standard deviation. This standardization in manufacture and the fact that the cache is made of a single-source high-quality lithic material may indicate that the cache was either made by a single individual or by individuals with a very rigid tolerances for manufacture.

## Discussion

The primary explanations for Clovis caching relate to colonization (Wilke 1991; Meltzer 2002). Kilby (2008) hypothesized that if caches were primarily associated with colonization, the result should be the movement of people, and thus raw materials, in a generally southward and eastward direction as new populations moved across the continent. Further, that if caches represent emergency stores of material for wandering

Table 5. 4 Weight (grams) of lithic material in Clovis Caches

| **Cache** | **Total** |
|---|---|
| Anadarko | 5727.8 |
| Anzick | 16,640 |
| Busse | 6425.1 |
| Crook County | 2948.2 |
| deGraffenried | 1284.2 |
| Drake | 505.7 |
| Fenn | 8459.1 |
| Franey | 1966.0 |
| Green | 678.9 |
| Keven Davis | 364.9 |
| Pelland | 156.5 |
| Richey-Roberts | 5390.9 |
| Sailor-Helton | 14619.6 |
| Simon | 7973.4 |
| Watts | 4462.6 |
| West Bank | 448.1 |
| **West Bar** | **5538** |

explorers, they would be expected to be generalized and diverse in order to supply Clovis people with tool materials necessary to meet a "range of conditions that cannot be fully predicted". But the Clovis reduction technology already accommodates exactly that. To meet the same needs, all that is required to be present in any given cache are bifacial and tabular cores—in fact, the more generalized and less diverse, the better off the group/person is when they retrieve the cache, as they are not limited to the previously created tool selection; they are able to transform the cores into any tool they might require. Diversity under this scenario is a limitation, not a benefit. Kilby came to similar conclusions and proposed a range of possibilities for cache behavior. Kilby divided Clovis caches into four broad types:

1) Insurance caches (based on Binford 1979), which are generalized based on "what might be needed at the location at some point in the future"
2) Seasonal/Passive caches (also based on Binford), which are cached in anticipation of need for specific, future pursuits;
3) Load Exchange caches, which are stored at their place of use in order to free up pack space, and;
4) Afterlife caches, which are not meant to be retrieved, but to be utilized or to otherwise always remain with a specific, dead individual.

Each of these cache types accommodates colonizer adaptations in different ways, particularly if Clovis caches represent a deliberate means of information exchange within a colonization scenario. Specific functions of the tools held in the cache under any of the given schemes are not particularly important because Clovis technology accommodates a broad range of needs by its conservative nature. Afterlife caches may be expected to vary from this, as grave offerings are often personal, even if they are meant to assist in the afterlife—an essentially untestable hypothesis unless human remains are recovered with the cache.

Gillespie (2007) has proposed that Clovis caches may represent a means of transferring cultural information to the landscape. Humans do this all the time—think of "Blueberry Hill" in any given town or possibly the Dome of the Rock in Jerusalem. In essence, a Clovis person participates in "enculturating" the landscape any time a cache is left behind. Under this hypothesis, forager caches might play a significant role in colonizer landscape learning. As foragers "map on" to the landscape, the act of leaving high-value goods behind may serve several critical functions, which might be related to the process of remembering the overall geographic setting. Because colonization requires the acquisition of detailed landscape information, geographic and geomorphic indicators are critical to the process. Deposition of high-value caches in geomorphic settings that are unique or otherwise relatively simple to recall, would help ensure both recovery of the tools, while at the same time signaling specific resources or land-use areas.

If caches were left with markers, such as platforms or mounds, they would act as a historic record of land use—serving a secondary colonization function of demarcating foraging territories or possibly signaling your presence to other colonizers, related or not. Similarly, under a colonization scenario, the specific content of caches would certainly indicate the presence of local resources—stone caches with low to no variability in lithic raw material might indicate the presence of a nearby stone resource to extended family or band members travelling in different foraging groups.

Figure 5.18 shows the general location of the West Bar cache, the Richey-Roberts cache and the Beezley chalcedony source area. It is conceivable that colonizers utilized the unusually large point bars on the mainstream regional rivers as cache locations. Such landforms are easily recognizable, unequivocal in their nature and, at least after the megaflood period, not subject to active erosion or deposition (stable surfaces).


Figure 5.18 Location of point bars associated with Clovis Caches, Columbia River, Washington State

Of course, it is also possible that much simpler explanations exist. Foragers who moved across the landscape had to balance their short-term needs, such as food and water, with longer-term requirements, such as lithic resources which are not always near food and water sources. Mesic environments and certainly littoral environments, such as those present across the Scabland at the close of the Pleistocene, may have accommodated both needs. The presence of a high-quality lithic raw material source within this favorable environment would have been highly valuable to colonizers, at least during the relatively temperate seasons. In the cold season, the uplands of the Beezley Hills were likely buried in snow making raw material exceptionally difficult to procure during the winter months to foraging groups who over-wintered in the area. Cached stone in these situations would come in very handy. It is possible that the most parsimonious explanation for lithic caching during the colonizer period is simply related to day-to-day storage; there may be no need to invoke anything more than daily use to explain a good number of known caches.

## Conclusions

In Clovis cache collections without fluted points, Clovis affiliation may be supported by technological hallmarks such as systematic overshot flaking on bifaces (Bradley 1993) and prismatic blades produced from prepared cores (Collins 1999). Several lines of evidence suggest that the West Bar cache is consistent with Clovis caches. Although it is not an attribute of Clovis technology per se, the presence of a utilized (faceted) hinge fracture and burination on one of the artifacts is consistent with other Paleoindian assemblages (References). Clovis-specific attributes include the execution of classical overshot flaking, broken, remnant (squared) edges on the biface margins, and the use of exceedingly high quality lithic raw material. The West Bar cache, made on Beezley chalcedony, illustrates the importance of the local, high quality raw material with at least one colonizer group.

## CHAPTER 6
## GEOARCHAEOLOGY OF THE COLONIZER PERIOD IN THE PACIFIC NORTHWEST

Chapter six presents an analysis of known early Colonizer sites including sites that are new to the literature that I have located and investigated, within the context of the regional geoarchaeological framework. This chapter focuses, site by site, on common landscape and geomorphic attributes shared by these early sites. The purpose of this chapter is to present a broad overview of known archaeological landscapes in order to demonstrate the ability to extrapolate this knowledge to other locations with high probability of identifying colonizer period archaeology. I have conducted geoarchaeological work at many of the sites reported here. Those sites with stratigraphy excavated by others are clearly indicated as such, although I provide my own interpretation within the context of this dissertation work.

The core of the data that is presented here is intended to incorporate aspects of Chapter 3, The Landscape Context and Chapter 4, Paleopedology into a geoarchaeological framework. Many stratigraphic sections are presented in this chapter; the goal is to demonstrate recurrent stratigraphic sequences interpreted from original research in this dissertation as well as analyzing and reinterpreting stratigraphic sections that were developed by other archaeological researchers through time. The final product of analysis of these stratigraphic sections is compiled and presented as a geoarchaeological model in the concluding chapter.

Development of the geoarchaeological data has required careful, systematic analysis of many stratigraphic sections (termed "exposure trenches") which are presented in Appendix 1. Methods of analysis followed standardized approaches for Quaternary geology and pedology; a detailed methods section is presented below. Details of the supporting data are presented in Appendix 1, including a table that identifies stratigraphic profiles which make up the type transects of the Bishop and Badger Mountain geosols as well as classifying each section by depositional environment. Where relevant, I have indicated which stratigraphic sections in Appendix 1 correlate to the following site interpretations.

### Field Methods
Field methodology for the collection of geoarchaeological data followed standardized methods used by the author for the past 20 years. Horizontal and vertical control for the recording and collection of stratigraphic profiles and sediment samples was determined as measured from the ground surface to depth. Stratigraphic profiling and sampling followed the excavation of pie-shaped (essentially triangular) trenches, in order to allow maximum visibility and to provide a rapid mode of egress should the trench fail.

Generalized soil and stratigraphic profile descriptions were developed from the profiles and conform to standardized terminology employed by the Department of Agriculture, Natural Resource Conservation Service (Soil Survey Staff).

### Procedures for recording soil characteristics in the field
Soil profile locations are identified in the front of Appendix 1, figure A1. The stratigraphic sections, consisting of more than 100 trenches and cutbanks (hereinafter

"exposure trenches") were logged in the field using standardized methods. These included identifying, measuring and recording the horizons in a soil profile at each road cut or trench. The physical and chemical properties that characterize each horizon are measured and recorded. The soil profile was photographed and soil samples were recovered from each horizon. Materials used to collect the data are presented below, with methods of each step presented in the section that follows. All data were recorded on a soil characterization data sheet and compiled in the descriptions presented in Appendix 1. Soil data sheets and sediment samples are stored in long-term curation at the Wanapum Heritage Center Repository Museum under a storage agreement that provides researchers access to the data, in perpetuity.

**Materials**

1. Spray mist bottle full of water
2. Acid bottle
3. Nails and tape or other marking device that can be pushed into a soil horizon
4. Soil Characterization Data Sheet
5. Trowel, shovel, or other digging device
6. Munsell soil color charts
7. Marking pen
8. Meter stick, tape measure
9. Camera

**Process of Identifying and Measuring Horizons**

1. Whenever possible the sun shone on the profile.
2. Using a trowel or knife, exposures were "plucked" by removing a few centimeters of soil off of the profile to expose a fresh soil face and to get an understanding of the soil structure and horizonation.
3. The face of the profile was wetted with a sprayer after the initial observations were recorded on a dry face.
4. Beginning at the bottom of the profile, soil characteristics were recorded moving towards to the top of the profile.
5. Working in a straight vertical line, a marker was placed (nail with tape) at the upper and lower horizon contacts to clearly identify them.
6. The top and bottom depth of each horizon were measured beginning at the top of the profile, the 0 cm mark.
7. The top and bottom depth of each horizon were recorded on the Soil Characterization Data Sheet.

**Measuring Structure**

1. Using a trowel or other digging device a sample of soil from the horizon being studied was removed.
2. Holding the sample gently in hand, the soil was examined to determine its structure.

Possible choices of soil structure are:

- **Granular**: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.
- **Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.
- **Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.

- **Columnar**: Vertical columns of soil that often have a white, rounded salt "cap" at the top.
- **Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.

3. Structure was recorded on the Soil Characterization Data Sheet.

**Measuring Soil Consistence**

1. A ped from the soil horizon being studied was removed. If the soil was very dry, the face of the profile was moistened by spraying water on it.
2. Holding the ped between thumb and forefinger, the ped was gently squeezeed until it failed.
3. One of the following categories of soil ped consistence was recorded on the Soil Characterization Data Sheet.
   - **Loose**: trouble picking out a single ped and the structure falls apart before you handle it.
   - **Friable**: The ped breaks with a small amount of pressure.
   - **Firm**: The ped breaks when you apply a good amount of pressure and the ped dents your fingers before it breaks.
   - **Extremely Firm**: The ped can't be crushed with fingers

**Measuring Soil Texture**

Soil texture was determined in both the field and the lab following standardized procedures (finger ribbon test in field, nested sieve and pipette in lab).

**Photographing the Soil Profile**

1. A metric tape was laid across the profile face with the 0cm mark at the surface.
2. Profiles were photographed so that the horizons and depths can be seen clearly.

**Boxing the Soil Samples**

In order to create a permanent record of the soil profile, each soil horizon was sampled, with peds intact, into a custom-designed soil box. Each soil box contains eight separate compartments that will allow the soil profile to be viewed in proper stratigraphic order. Soil horizon depths corresponding to each sample were recorded on each compartment. The soil boxes are archived in the Wanapum Heritage Center repository and are available for examination by bona fide researchers.

**Site Interpretations**

The following site descriptions are intended to provide an overview of Colonizer site Geoarchaeology. They are interpreted from field descriptions of original researchers, my own field-based observations, and in some cases, re-interpretation of the original field data.

Bishop Spring, Washington

The Bishop Spring Site is located on the western margin of the Columbia Plateau, in Grant County, Washington. Preliminary fieldwork at the site provides evidence of multiple archaeological components ranging from Upper Pleistocene to early Holocene in age. Buried volcanic tephras and organic-rich Upper-Pleistocene and Holocene stratigraphy provide an ideal environment for numeric and relative dating of the archaeological deposits.

Artifacts recovered from controlled excavation (Meirendorf 1986) and by fortuitous collecting of local residents of the area include stemmed points, macroblades derived from prepared cores, blade core fragments, graving and boring isolated spur tools. Geomorphic and stratigraphic investigations provide details of the depositional setting and contribute to the overall geoarchaeological interpretation that the site represents a unique sediment and plant macrofossil trap utilized by early Paleoindians.

The site is located on a structural bedrock bench of the Grand Ronde formation of the Columbia River Basalt Group 300m above the floodplain of the Columbia River. Sedimentary stratigraphy exposed in a trench on the margin of the spring and in a single auger core reveal a continuous, uninterrupted record of deposition beginning with Upper Pleistocene Missoula flood sediments, continuing through the Holocene, capped by Mt. St. Helens 1980 tephra.
Preliminary stratigraphic investigations based on my fieldwork there indicate the site tephrochronology includes the presence of four volcanic tephras occurring in succession, beginning with Mt. St. Helens Set S (12.8 KBP), Glacier Peak layers G (<11.6 KBP), Mazama (~7.2 KBP), and Mt. St. Helens 1980. These diagnostic tephras bracket primary air fall and fluvially and colluvially redeposited silt beds, into which paleosols formed and were buried. Paleosols are present as well-formed A horizons with relict plant macrofossils. Based on stratigraphic relationships, the site is likely to be one of the earliest sites with stratigraphic integrity on the Plateau. Distinct diatom horizons are present in the spring sediments. I sampled the diatoms, thinking they were tephras, but Nick Foit at the Washington State University microbeam lab identified the samples as diatoms. Given the appearance of the artifact assemblage, it seemed that Glacier Peak and/or Mt. St. Helens Set J tephra should be present in the sediment stack. I returned to the site, focusing on pre-Mazama stratigraphy and sampled each distinct horizon. Rather than guessing which units might contain tephra, I submitted all of the sediment samples to Nick Foit and he was able to positively identify two Glacier Peak horizons (represented by disseminated glass shards in the sediment matrix). These were tied to the stratigraphic and archaeological information gained by Mierendorf in 1986 to complete the preliminary site stratigraphy that is presented in Figure 6.1.

The Badger Mountain geosol is present immediately underlying the Mazama tephra. Approximately 20 centimeters separates the Badger Mountain from the underlying Glacier Peak horizon. Consistence increases with depth at the site, but is consistent throughout the basal units which include the Bishop geosols. Redox is present in the Badger Mountain horizons, probably as a result of water perching on the underlying Bishop geosol. Meirendorf's 1986 testing field notes indicate that he recovered artifacts in highest concentration just below the horizon of Glacier Peak tephra (~11.6 KBP). The water table is present just 15 centimeters below that horizon, and excavations had to be terminated as a result (Mierendorf 1986). Appendix 1, sections 27, 32, 35,36,37,38 and 39 are part of the Bishop geosol type transect, and are located in proximity to the Bishop Spring site.

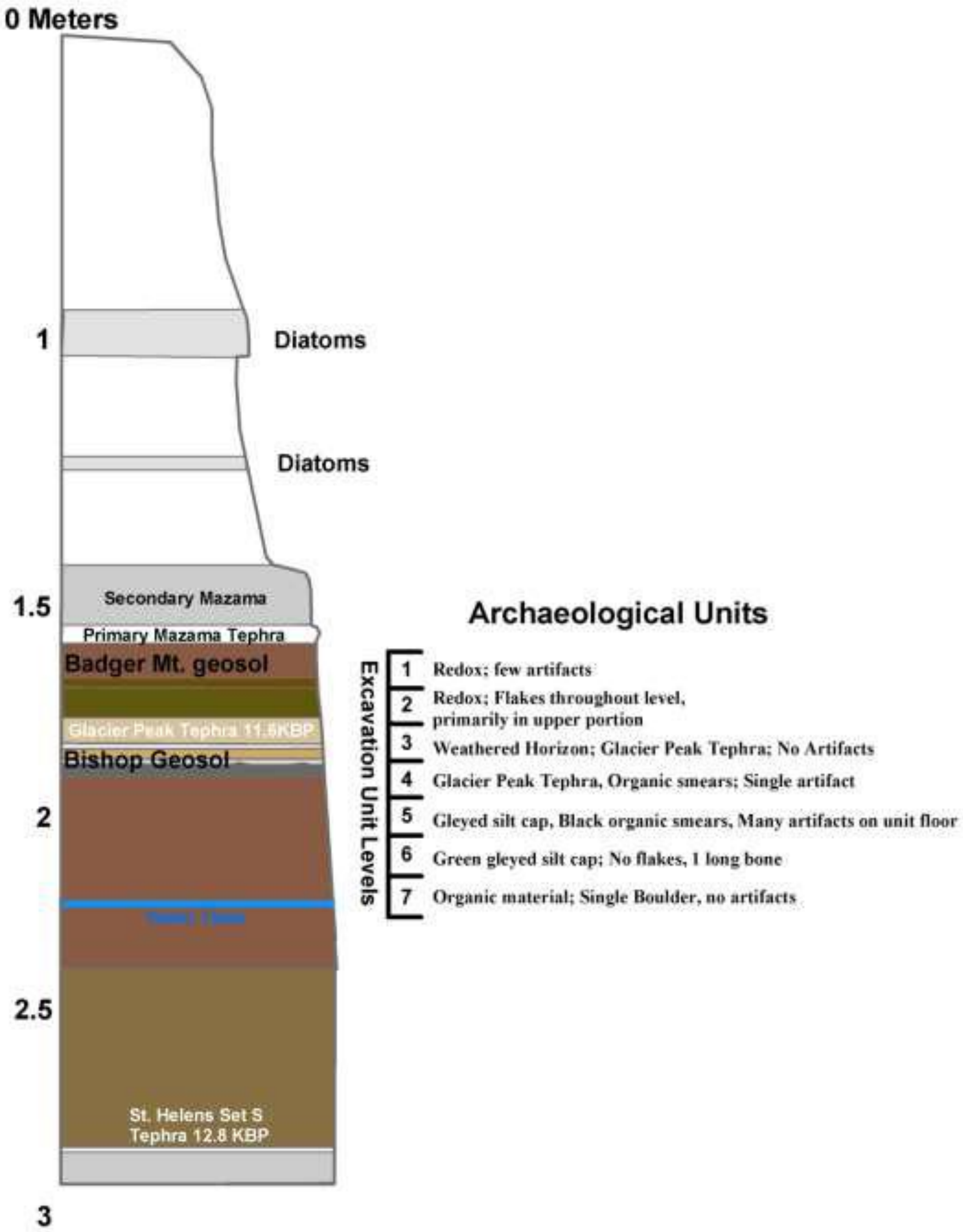


Figure 6.1 Stratigraphy and archaeological units, Bishop Springs (after Mierendorf 1986)

**BPA Springs**

Located on a bedrock bench near the Wanapum Dam, the BPA Springs site is a latest Pleistocene–early Holocene site discovered in late 2002 during a comprehensive archaeological survey that targeted early sites via systematic shovel probing. The site had no surface expression, but a stemmed (Windust) point and flakes were recovered in shovel probes, with projectile point typology leading to the interpretation of this site as colonizer in age.

In 2003 I undertook fieldwork at the site. Sediments consist of rhythmically bedded Pleistocene flood sediments with Mt. St. Helens Set S tephra within the final five flood units. The fine-grained flood sediments have prominent redoximorphic features extending through the base of the overlying unit, similar to deposits at the Sentinel Gap site. Redox mottling suggests a fluctuating water table at the close of the Pleistocene, perhaps likely in response to unstable climatic conditions during the Pleistocene-Holocene transition. The overlying sediment is nearly homogenous eolian sand capped by a moderately deflated surface. Artifacts were located in the shovel probes overlying the rhythmites within the homogenous sands. Controlled excavations have yet to be performed, exposure trench 15, Appendix 1 is located at the BPA springs locale.

**Cooper's Ferry (10IH73)**

The Cooper's Ferry site (Butler 1969; Davis and Schweger 2004) is located in an alluvial setting on the Little Salmon River in western Idaho. Davis and Schweger (2004) established the stratigraphic baseline in a synthesis of the lithostratigraphy. pedostratigraphy, stable isotope geochemistry, cultural stratigraphy, and chronostratigraphies.

Davis and Schweger (2004) describe pedogenic development in three geologic deposits at the site. The Rock Creek Soil, an informal soil defined by Davis, is dated between 13 KBP and 10.7 KBP at multiple sections in the vicinity of the Cooper's Ferry site. These dates are consistent with Bishop geosol. The American Bar soil with a date of 6 KBP, but clear stratigraphic association with earlier radiocarbon dates at the Cooper's Ferry site, conforms well to the Badger Mountain geosols. In particular, its higher carbonate content is a defining feature in the central interior Columbia Plateau. The surface soil is an incipient A horizon that is ubiquitous to sediment sequences throughout the region.

Figure 6.2 (after Davis and Schweger 2004) displays the Cooper's Ferry site stratigraphy. Site formation at Cooper's Ferry is dominated by alluvial and eolian depositional processes. Upper Pleistocene loess (L3 and L4) caps an alluvial base, the age of the loess ranges from 11.3 to 10.7 KBP. Glacier Peak tephra fell onto this surface and a soil formed into its cap. This pedostratigraphic relationship is a characteristic of Bishop geosol formation. Alluvial deposition buried the Bishop

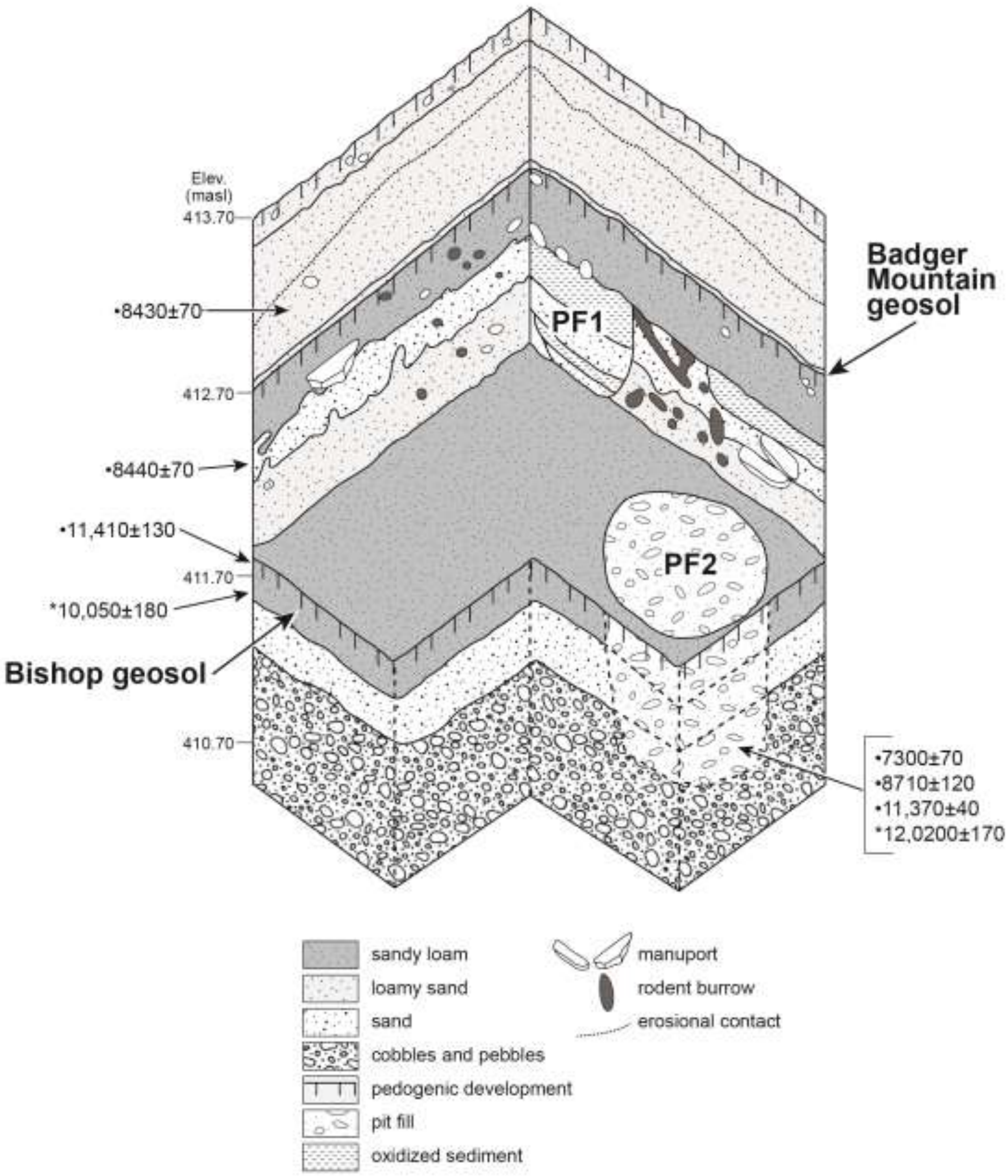


Figure 6.2 Stratigraphic sequence indicating Badger Mountain and Bishop geosols, Cooper's Ferry site (After Davis and Scheweger 2004).

surface, conforming with the regional alluvial sequence presented in Chapter 3, which presents an Upper Pleistocene aggradation followed by an early Holocene aggradation.

**Cow Creek**

45AD23 is located in the Cow Creek drainage of eastern Washington. The site is located across a terrace sequence that spans upper Pleistocene through late Holocene. I undertook fieldwork at Cow Creek in spring 2010. The bulk of site materials appear to exist at or near the Mazama contact; my pedostratigraphic work indicates that the sequence begins with the Willow Lake Paleosol, expressed as a buried A horizon

(Figure 6.3). At a depth between 60 to 80 cm, the soils sequence has a Bkqm horizon with the abrasive feel of tephra. Post Mazama tephra in this area is restricted to Mt. St. Helens Set Y which erupted between 3-4 KBP (Mullineaux 1976). This date conforms well to the Willow Lake horizon just overlying. Mazama tephra is present in the middle portion of the stratigraphic section. A radiocarbon date of 7,610± (Beta 40283874: Table 4.2) was obtained on organic material in the Badger Mountain geosol, immediately underlying Mazama tephra. An attempt at dating the deeper levels was unsuccessful, returning an age of 6120 ± 40 (Beta 282908: Table 4.2). It is likely that the open clast-supported framework in the lowest section of alluvium allows for organic matter to travel throughout as it is recharged from agricultural settings adjacent to the stream, contaminating the older sediment (what little matrix is available) with more recent carbon.

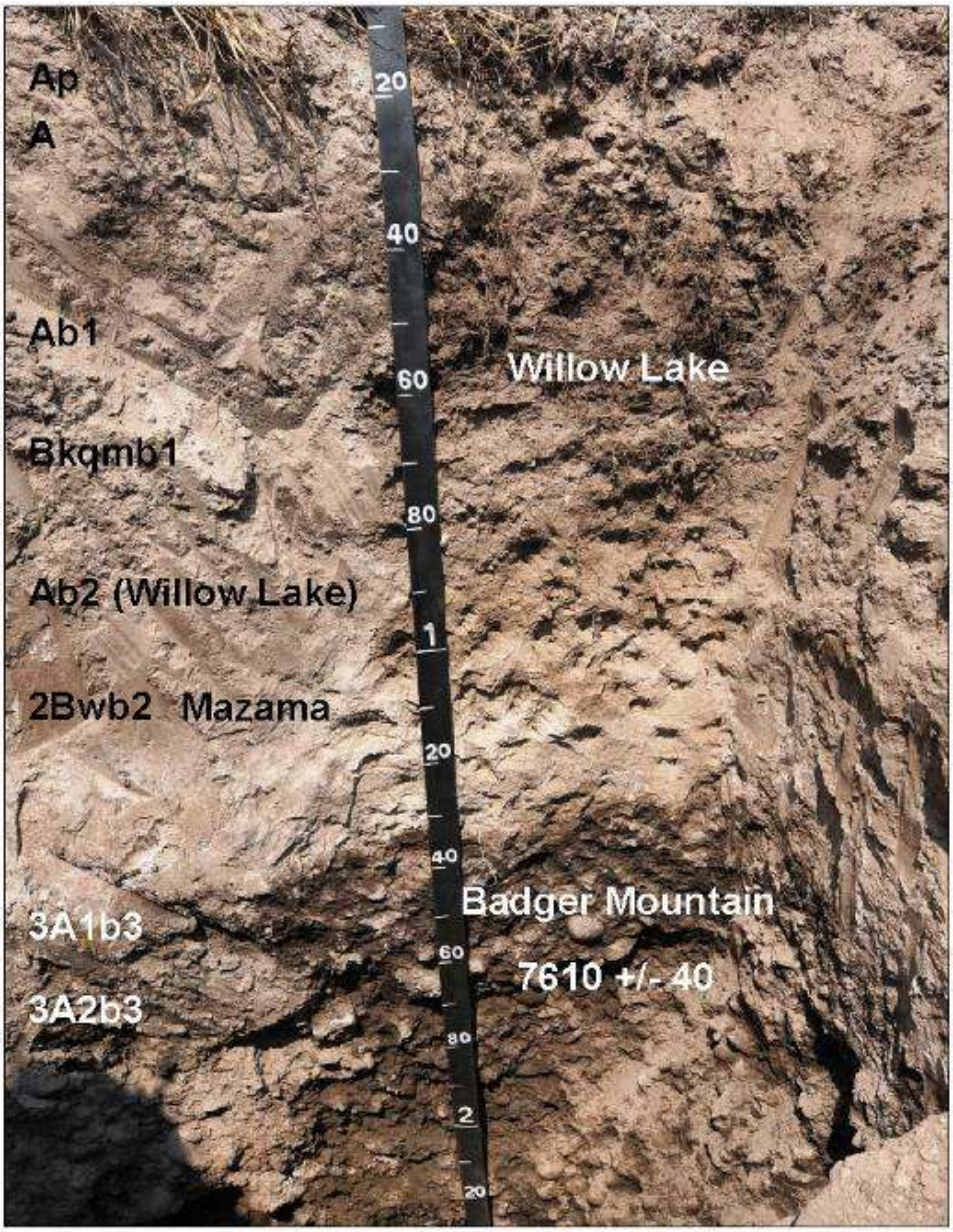


Figure 6.3 Stratigraphic situation, Cow Creek, AD23

## Granite Point

Granite point represents a relatively classical "Snake River" sequence, as defined by Hammatt (1977). Based on Leonhardy's 1969 work, I interpret that the Willow Lake Paleosol is present underlying an eolian cap (Figure 6.4). The old terrace that Willow Lake formed into displays a cut and fill by the late Holocene aggradation. Mazama tephra is present and the Badger Mountain geosol immediately underlies the ash, forming into the early alluvium (A2) and a buried sand dune. No evidence of Glacier

Peak tephra or the Bishop geosol is recorded in the stratigraphic profile or the accompanying field notes (Leonhardy 1970).

**Horse Heaven Hills, Washington**

Rice (1969) described the co-occurrence of early projectile forms with the surface remains of extinct animals in a complementary journal article to Fry (1969). While no direct association between the artifacts and extinct animals was demonstrated—only proximity in a surface environment—Rice outlined several factors that increase the probability of finding this association at the Horse Heaven Hills paleontological localities. Rice argued that the Horse Heaven Hills are bounded on three sides by major river valleys, each with evidence of colonizer sites. That use of areas outside the

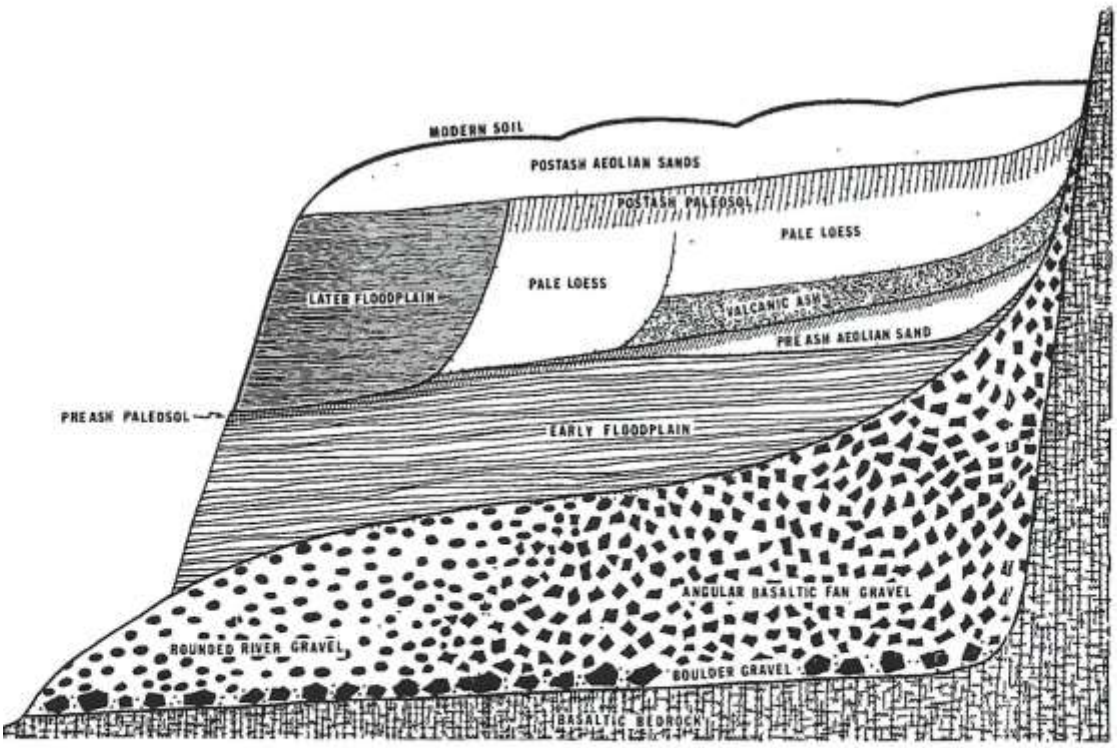


Figure 6.4 Granite Point Stratigraphy (after Leonhardy 1970).

uplands should not be considered exclusive to those environs. The most important factor he considered is that the fossil locales are above the maximum extent of the scouring effects of the megafloods. Paleontological and archaeological material would be found *in situ*, with no potential for disturbance by the floods. Rice also points to the existence of other upland sites, such as Lind Coulee as evidence of upland land use.

The geomorphology and stratigraphic situation of the fossil localities is briefly described in Fry (1969). The Columbia River Basalts are incised by deep drainages, which have correspondingly deep alluvial fills. Outside the incised cut-and-fills, the upland slopes are covered in loess. The inset alluvium is a product of stream flow, likely related to interbed spring and meltwater runoff, draining the high upper slopes of the Horse Heaven Hills.

Fry's (1969) work indicates that eroded sections of the canyon walls expose Mazama and Glacier Peak tephras. He states that one mammoth specimen was exposed beneath more than two meters of Glacier Peak tephra. Given the high number of extinct sets of remains and potentially associated artifacts, this set of sites is another practicle example of the need to focus colonizer research on upland locales.

**Indian Sands, Oregon (35CU67C)**[3]

A key late Pleistocene/early Holocene archaeological site located within the colonizer landscape of coastal Oregon is the Indian Sands site (Davis 2006). Based on Davis's work the stratigraphy of the site is comprised of Pleistocene-age aeolian dune sands with interbedded paleosol horizons (Figure 6.5). Moss and Erlandson (1995, 1998) report early evidence of shellfish exploitation at Indian Sands on the basis of three radiocarbon dates on mussel shell collected from a deflation surface, which ranged in age between 7.8 and 8.3 KBP. Excavations conducted by OSU archaeologists between 2000 and 2002 revealed a significant subsurface archaeological component. A charcoal sample found in association with lithic artifacts at the base of the culture-bearing 3Ab paleosol returned a radiocarbon age of 10,430 ±150 (Davis 2006; Beta 170406). Four additional TL samples taken by Davis from Unit F in 2002 serve to evaluate the timing of sedimentation and pedogenesis at 35CU67C, returning middle Holocene ages.

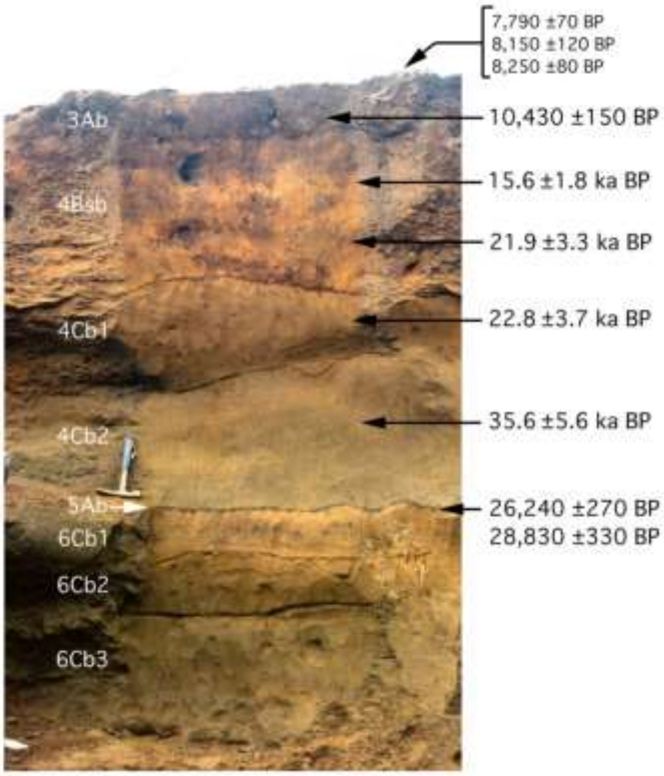


Figure 6.5 Stratigraphy of Indian Sands Site. Earliest Holocene occupation is at cap of stacked sequence (after Davis 2006 Tables 2&3).

The 4Bsb and 3Ab horizons seen in the stratigraphy of the Indian Sands site relate to the late Pleistocene-early Holocene transition. The 4Bsb horizon represents the eroded

[3] This description of Indian Sands was reported in a co-authored paper (Lenz et al. 2008). I was the primary author; Loren Davis and Joe Dragovich were co-authors.

subsoil remnant of a late Pleistocene-aged paleosol developed on sandy loess (Davis 2006) and is associated with a TL age of 15,600 ±1800 cal, possibly the local expression of the Bishop Geosol. The 3Ab horizon is an exhumed paleosol bearing moderately developed fine subangular blocky structure, which unconformably overlies the eroded 4Bsb surface. Based on their gross pedogenic and micromorphological qualities, the 4Bsb-3Ab sequence indicates a shift from cold, dry, dusty coastal environments associated with lower sea levels and late glacial climates to more mesic environmental conditions with a mostly submerged coastal plain by the terminal Pleistocene (Davis 2006).

**Lee mesa site (45GR756)**

In order to complete a Masters Degree field project, Aaron Kuntz (2009) excavated what was considered to be a late Holocene basalt mesa-top. After the untimely death of Principal Investigator Pete Rice, I was asked to take over the role of PI. The archaeological site is located on an elevated Columbia River Basalt mesa-top at the western margin of the Columbia Plateau. The mesa has a weakly concave center which slopes towards the south. Sediments on the mesa include a thin loess mantle with variable thickness over basalt. Archaeological features are present on the surface of the mesa, including house pits and basalt manuports. Both the Badger Mt. and Bishop Geosols have formed into the loess cap; the Badger Mt. is welded onto the Bishop, likely as a result of perched water in the shallow loess deposit, with near-saturated conditions during the wet seasons. The saturated conditions have resulted in salt solubility, dispersing the finest grained loess which is leached downward in the soil profile.

Figure 6.6 shows my interpretation of a profile at the site with pedologic detail. The AB1b1 horizon is the Willow Lake Paleosol. It overlies the AB2b1 horizon which includes Mazama tephra and places it stratigraphically as the Badger Mt Geosol. A significant paleosurface is visible as a stone line in the profile wall at the cap of the Badger Mountain geosol. A stone-line is also present at the surface of the Bishop, the Btb3 horizon which excavators initially mistook as bedrock. This horizon is as highly indurated as I’ve experienced in twenty years of fieldwork. Given the nature of the excavation on a very

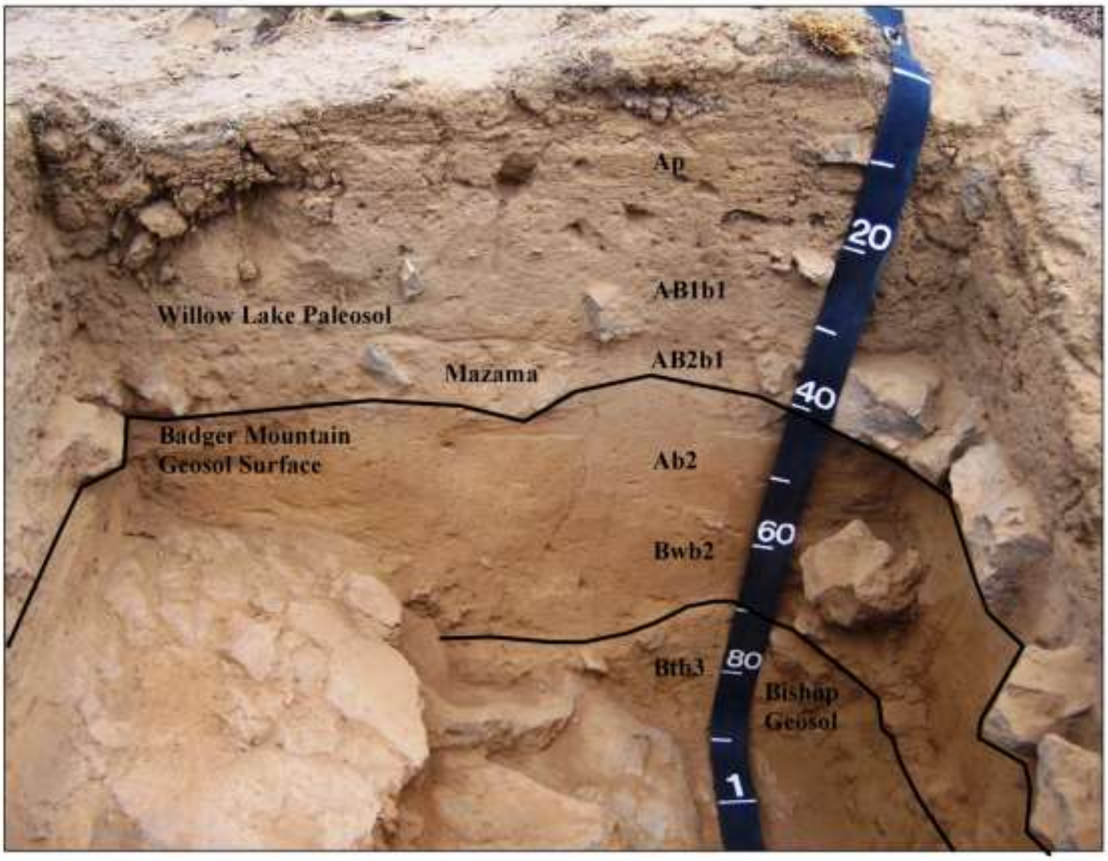


Figure 6.6 Stratigraphy at the Lee Mesa site (After Kuntz 2009)

small, isolated basalt mesa, and given the fact that I was the project PI, I instructed the excavators to continue digging through the Bishop geosol. By force and pick hammer, the excavators removed the soil peds and attempted to shake them in the screen. Figure 6.7 shows the result of extended shaking; the peds were rounded, but would neither go through the mesh by natural shaking, or by all attempts to press them through. Aaron Kuntz took the peds to the lab where he soaked them overnight in a dilute sodium hexametaphosphate solution. He then wet-seived the peds, pouring them through the screen and recovered a single pressure flake. Recovery of the Bishop geosol member continued this way until in the end, five pressure flakes of Beezley chalcedony, similar in size and shape, were recovered. It is impossible for the flakes to relate to any cultural manifestation but the colonizer period, as they have been bound in the Bishop horizon for the better part of 13,000 years and through two major periods of pedogenesis, the latter of which welded the Badger Mountain geosol onto the Bishop. The artifacts that were recovered tell us almost nothing of the people who made them, outside of their selection for Beezley chalcedony, which is important. More importantly, by his persistence, Kuntz provides an example of the need to persevere in research endeavors; even if and especially when significant obstacles are present—Chapter 7 includes a short section on this topic, as it relates to colonizer site discovery. As a result of the perseverance of the research team, the Lee mesa site provides the first evidence for colonizer utilization of basalt mesa-tops on the Columbia Plateau.

Figure 6.7 Bishop soil peds, bound into nearly irreducible rock-hard soil fragments (left). Beezley chalcedony pressure flakes recovered fromthe Bishop soil peds (After Kuntz 2009).

**Lind Coulee**

In the eastern portion of the Columbia Plateau, coulees with underfit streams in their valley floors are common. These ancient waterways were deeply entrenched into the Columbia River Basalts well before the end of the last glacial period. Prominent coulees include Crab Creek, Rocky, Bowers, Lind, Washtucna, Old Maid and Dunnigan coulees. These coulee floors contain upper Pleistocene to early Holocene valley fills; some of these fills contain known colonizer archaeology. Lind Coulee is one that contains an early archaeological site that has been subjected to multiple periods of excavation and research.

Daugherty (1956) describes the difficulties encountered in excavating the Lind Coulee site. Carbonate in the paleosols made it difficult to excavate, and to differentiate between alluvial stratigraphic layers. Moody (1978) developed the site stratigraphy. She described an Upper Pleistocene base of indurated gravels, overlain by fine-grained sediment with Mt. St. Helens Set S tephra and clastic dikes, indicating that this is likely a touchet (fine grained megaflood) sediment. Aggradation 1 sediments overlie the flood sediment, and they contain Mt. St. Helens Set J tephra and the cultural sequence both overlying and underlying the tephra. Aggradation 2 sediments are present as an inset terrace into the A1. This deposit is overlain by eolian sediments containing Mazama tephra. Daugherty and Moody both indicate that cultural material at the site is found in these last three sediment bodies. Moody (1978) described 65 depositional episodes within “microstratigraphic” units. Based on malacology, she hypothesized that the alluvial units were deposited over a very short period of time, no greater than 150 or so years. Given our understanding of the age of the Mt. St. Helens Set J tephra and the Bishop and Badger Mountain geosols which contributed to cementation of the archaeological material, this short period of deposition is not plausible. Moody’s depositional units conform to aggradation 1 and 2 and they include the eolian sediment cap with Mazama tephra. This sequence is repeated in the arid portion of the Columbia Plateau, as described in Chapter 3. Radiocarbon dates at the Lind Coulee site range from upper Pleistocene through early Holocene, and culturally-modified bone in the deep horizons underlying the Mt. St. Helens Set J tephra (11.6 KBP) provides direct evidence that the site was used for several thousand, rather than several hundred years.

In the central interior of the Columbia Plateau, the Columbia Irrigation project has recharged Upper Pleistocene waterways. Deep alluvial sequences were emplaced at the close of the ice age in many coulees and along many tributary drainages of the central interior Columbia Plateau (Chapter 3). By the warmest portion of the early Holocene, these waterways had dried up, leaving abandoned channels except for ephemeral runoff throughout the Holocene. Figure 6.8 I display a graphic model of recharge at the Lind Coulee site. This model can be applied anywhere across the Columbia Plateau where irrigation recharge affects available water in topographic lows. Most importantly as it relates to the identification of colonizer archaeological sites, knowledge of this recharge model should lead archaeologists to environments that were wetted, therefore, suitable habitats for animals and humans at the close of the Pleistocene.

**Manis Mastodon 45CA218**

The Manis mastodon site is situated in a former Upper Pleistocene lake bed at the foot of the Olympic Mountains, west of the Cascade Range. Geoarchaeological fieldwork there by Morgan (1985) suggests that the Bishop and Badger Mountain geosols arepresent, although weakly expressed, in Manis sediments (Figure 6. 9).

Basal deposits are saturated gravels with slight mottling (redox) in the fine-grained matrix. This mottling is, of course, common in saturated sediments whose water table fluctuates, and it is also clearly correlated to stratigraphic sequences of other colonizer sites. Ponded deposits overlie the basal gravel, which are in turn overlain by the primary bone-bearing deposit, termed the “Manis horizon”. A slight change in

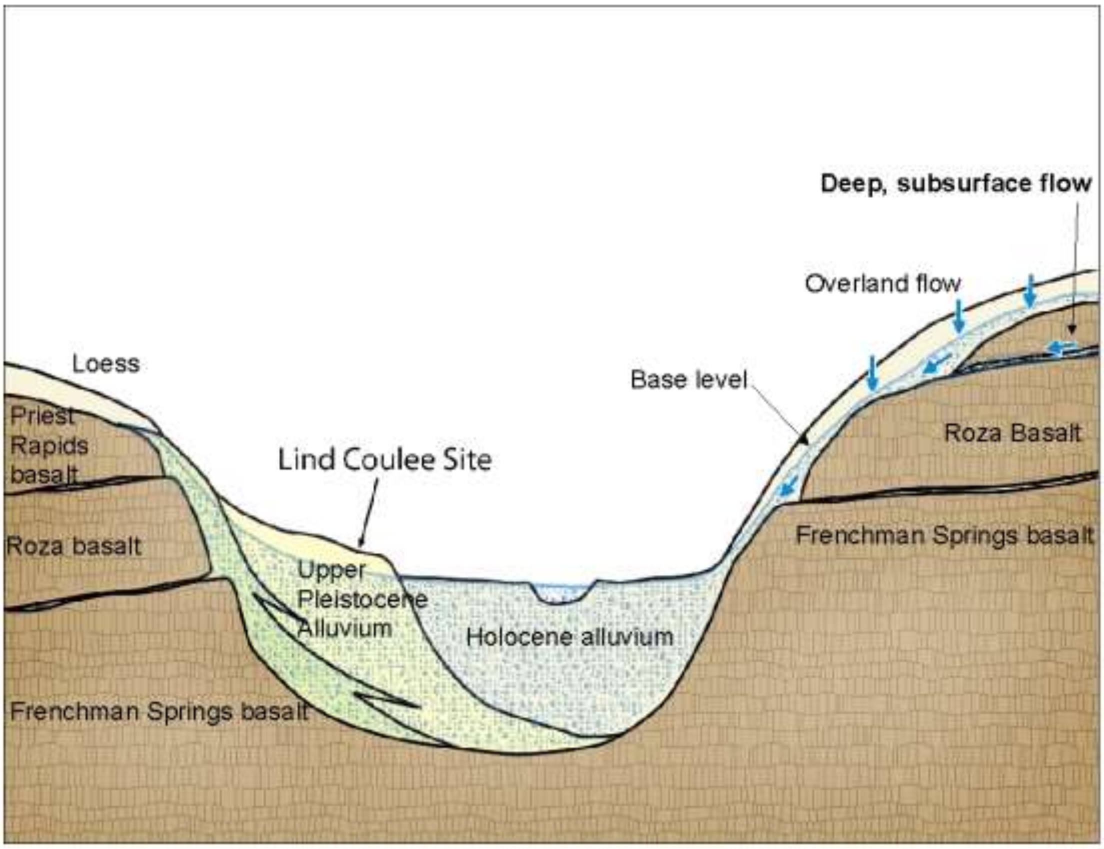


Figure 6.8 Groundwater recharge setting, Lind Coulee.

pedogenic structure suggests soil development—interpreted here as the local expression of the Bishop geosol.

These early levels are overlain by silty sand beds which are capped by diatoms. A moderate soil formed in the overlying unit, the Badger Mountain geosol. Its coarse, angular peds part to medium and fine blocks; to date this is the farthest north and west exposure of the Badger Mountain geosol. Early Holocene artifacts are found within the Badger Mountain soil. Discontinuous Mazama tephra buried the geosol, which is overlain by muck to the surface. No expression of the Willow Lake Paleosol appears to be present at the Manis site.

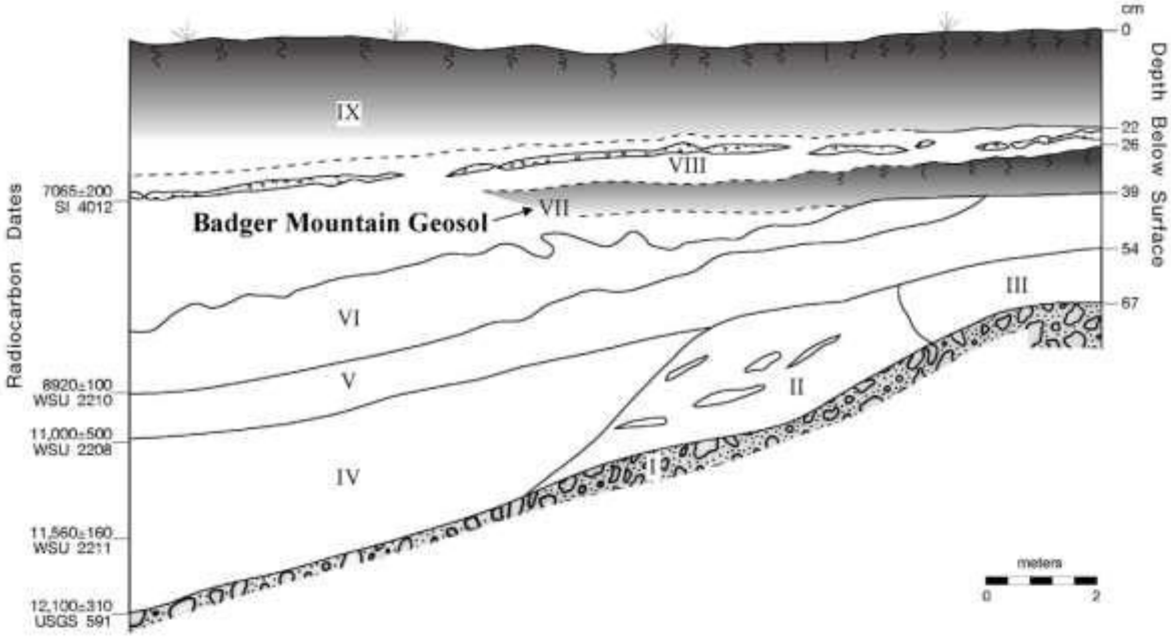


Figure 6. 9 Manis Mastodon Stratigraphy with Badger Mountain geosol noted (after Morgan 1985)

**Pilcher Creek, Oregon (35UN147)**

The Pilcher Creek Site is situated on the lower third of a south-facing slope below a small basaltic ridge. Colluvial and eolian sediments have accumulated to a depth of 4 meters in portions of the site, except towards the floodplain where the stratigraphy is compressed to 1.5 meters. Frank Reckendord, USDA soil scientist described the soils sequence during the primary excavations, Figure 6.10 provides a schematic overview of the site stratigraphy based on Reckenford's work.

The site is underlain by basalt which was buried by a gravelly body of reworked glacial till. In most areas across the site, the stratigraphic sequence is repeated and unbroken.

The lowermost portion of the profile is dominated by laminated, micaceous silt, representing a shallow lake. Glacier Peak tephra (~11.6 KBP) buried the silt, probably after the lake dried up. Archaeological material is mixed in the tephra, making Pilcher Creek one of the earliest documented sites in the region. Overlying the tephra is a buried soil, the Badger Mt. geosol. Archaeology is present throughout the geosol.

The paleosol crosses the Pilcher Creek site and was subdivided into three stratigraphic units based on soil discontinuities. A very distinct unconformity (discontinuity) separates the cap of the paleosol from the overlying Mazama tephra. Prior to Mazama ashfall, an erosional event removed the A horizon of the Badger Mountain geosol. Mazama fell directly on the truncated B horizon. The deepest portion of the buried soil formed into alluvium which had capped the Glacier Peak tephra. Between this period of soil formation and soil formation in what the authors term the “upper” soil forming

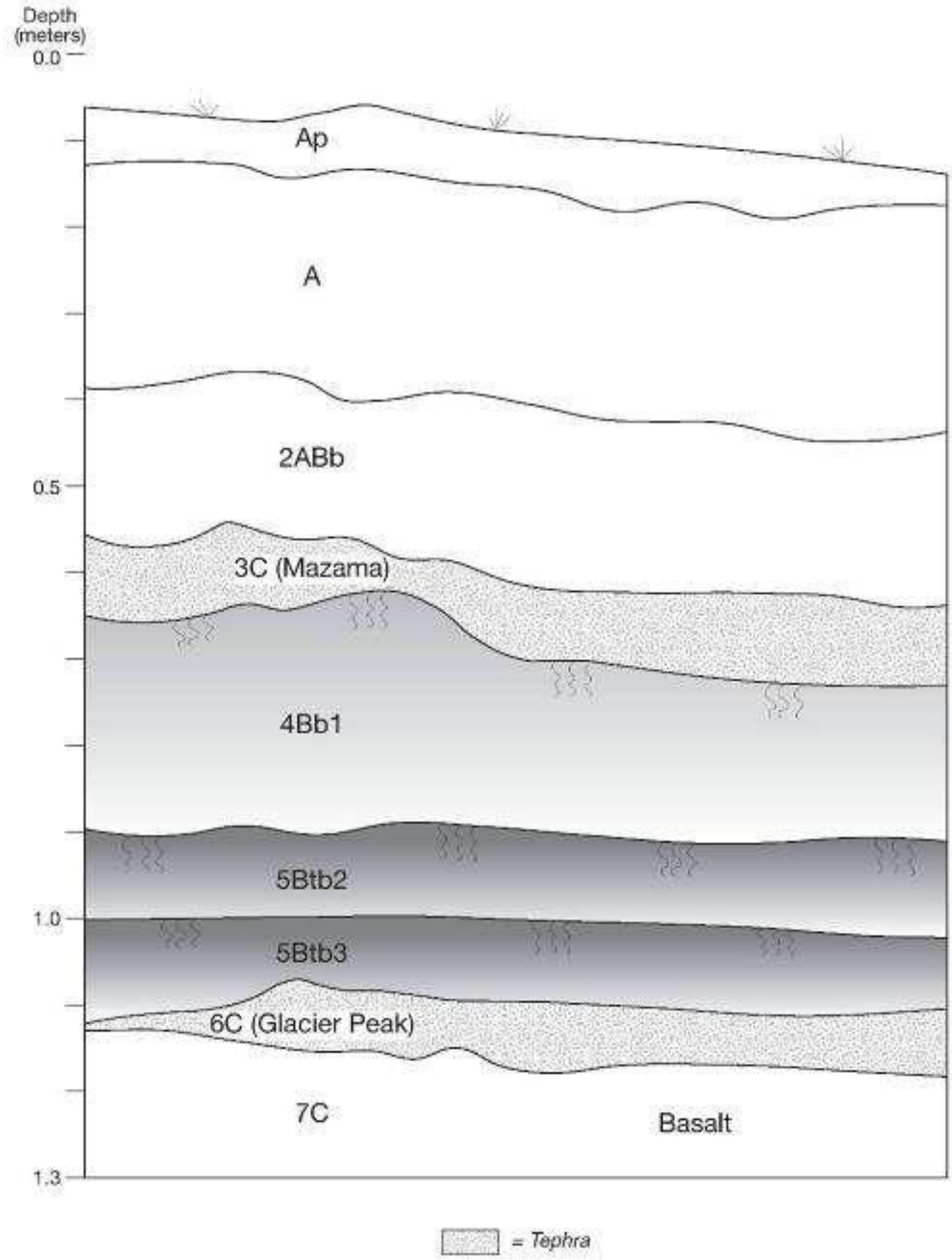


Figure 6.10. Schematic stratigraphic section (after Reckenford 1985).

period, was a period of colluvial deposition. This period of deposition must have occurred between 8 KBP and 11.6 KBP. Other sites with similar stratigraphic detail include Richey-Roberts, where a Younger Dryas age sand deposit separates the Bishop geosol from the Badger Mountain geosol. Insufficient chronometric data is available to make an air-tight case for the same situation here, but the simplest explanation is that the Younger Dryas cooling led to an influx of sediment, sealing the lower Bishop geosol and Upper Pleistocene archaeological deposits at the site.

## Richey-Roberts Clovis Site, Washington (45GR482)

Over the course of two summers I was able to conduct a trenching exercise to support development across the road from the Richey-Roberts cache (Schumaker 2006; Root 2008). In total I placed thirty trenches on a generally even distribution across the ~500 acre property between 2-3.5m in depth. The goal of the backhoe trenching was to determine whether Clovis-age and other stratigraphic markers that have been documented at the Richey-Roberts site (e.g., Contact A, Mazama and Glacier Peak tephras, buried soils) were present. Where possible, the backhoe trenches were extended to the cap of megaflood deposits—characterized by unconsolidated, clean, coarse sands and rock fragments and basalt "float", cobbles and small boulders deposited by late floods, marking a paleo-surface. The surfaces were mapped in order to interpolate the extent and depth of these horizons in proximity to the Richey Roberts cache. Excavation of the trenches was monitored for exposure of cultural material. Archaeological reconnaissance work was also completed during the trenching; more than 5000 subsurface probes with an average diameter of 30cm were placed in the field. Not one artifact was identified during the course of work.

The location of the Richey-Roberts Clovis site, although enigmatic under present, dry climatic conditions, is strikingly similar to other colonizer sites in the region when viewed from a geoarchaeological perspective. A paleo-wetland north of the site existed in a scour trench during Clovis times. Littoral, wetland environments were preferred by Paleoindians throughout the Columbia Plateau and Great Basin (Beck and Jones 1990, Bedwell 1973; and this work). Lind Coulee, Winchester Wasteway, Bishop Spring, Willow Lake and the Sentinel Gap site hold buried colonizer age archaeological sites that are similar to the Richey-Roberts site area.

Mehringer (1988) suggested that the Richey-Roberts project area lacks reliable stratigraphic markers for correlation and dating surface deposits. To the contrary, the Bishop and the Badger Mountain pedostratigraphy, together with regional tephras are ideal time-stratigraphic markers to assist with correlation of the archaeological deposits. The key limiting factor to their usefulness is the depositional substrate. In sandy material, such as the giant flood bars which flank and underlie the Richey-Roberts site, homogenous, relatively coarse sands allow even, well-drained flow for surface water. This condition precludes prominent soil formation and preservation—although discreet pedostratigraphic and megaflood features that are still useful stratigraphic markers exist (described below). On alluvial fans and in the low areas of the depositional basin formed by the scoured trough, geosols are buried and exceptionally well preserved.

### Surface Geomorphology and Paleoenvironments

The geomorphology of the site area developed at the close of the Pleistocene under extreme conditions. Upper Pleistocene scouring and flood bar deposition first deposited the base stratigraphy, although the majority of the channel bar was clearly built through and likely prior to the Pleistocene, based on exposures of highly indurated gravels on the margin of the East Wenatchee point bar south of the site (Figure 6.11).

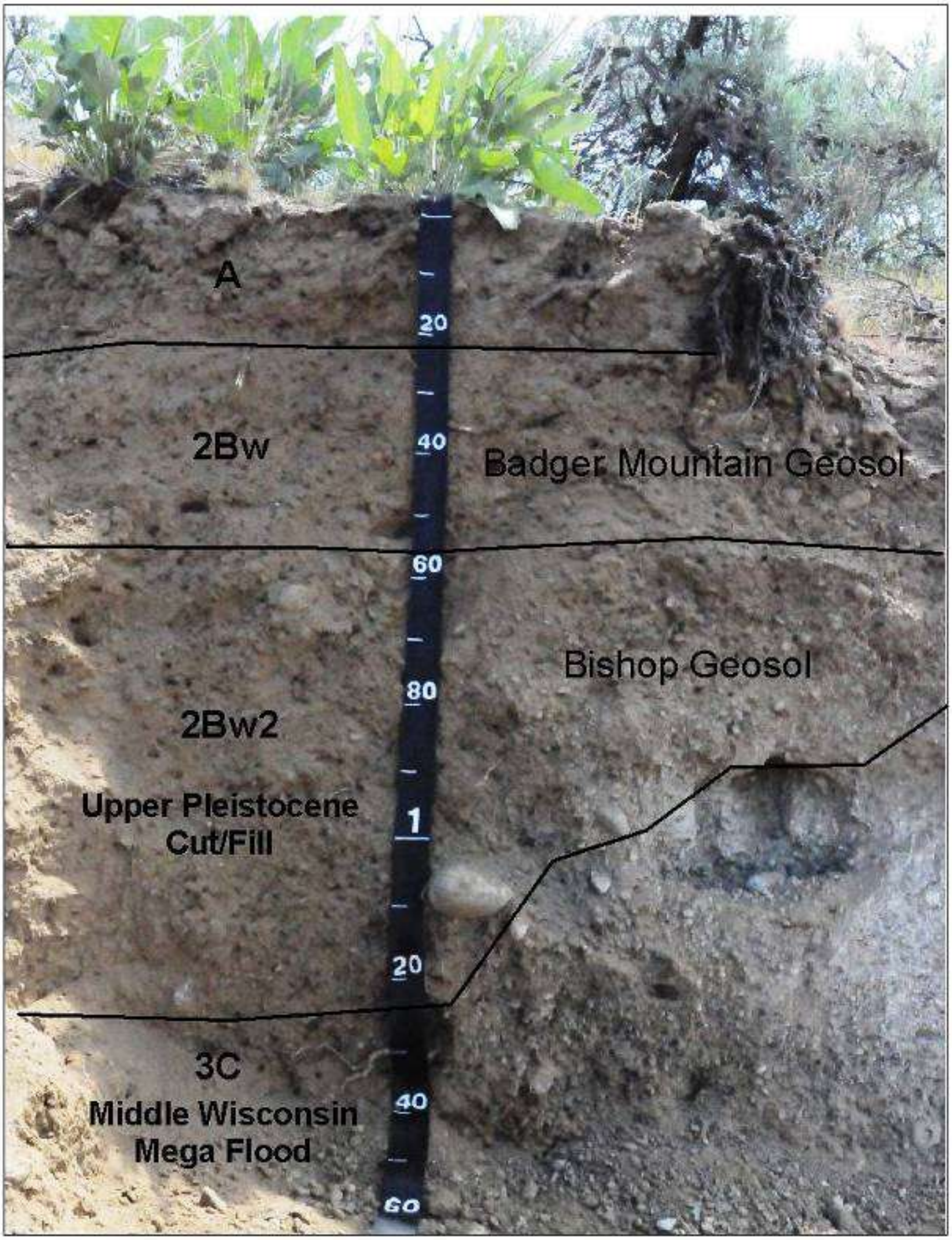


Figure 6.11 East Wenatchee Bar deposits south of Richey Roberts site. Middle Wisconsin deposits are highly indurated.

Based on dates presented in this dissertation research in Chapter 3, the final floods to top the 900 foot elevation at the Richey-Roberts site dated to some point in time after 12.8 KBP. Mt. St. Helens Set S tephra is not present in the sediment stack, indicating that scour and fill on the flood bar post-dates its eruption. Evidence of the late flood includes surface megaripples which form a series of shallow southwest to northeast trending troughs; the flood bar that underlies the site is a result of this large flood. As a result of the late floods, a deep scour trench formed along the base of the Badger Mountain anticline immediately north of the site area.

At some point soon after the scour of the trench by the large floods, alluvial fan deposition began filling the trench north of the site. Although the fan sediments are predominantly fine-grained, proximal fan deposits include basalt gravel beds. Glacier Peak tephra (11.6 KBP) is present in the distal fan deposits (Figure 6.12), redeposited in stacks of reworked sediment, incipient A horizons forming in between depositional events. This stratigraphic situation is reminiscent of Glacier Peak deposits reported by Stan Gough (1995).

The surface of the flood bar was stable after its deposition and the Bishop geosol formed. Cobble-sized basalt erratics are present on the flood paleosurface, the Bishop geosol surface. Loess rain and saltation off the flood beforms kept pace with pedogenesis in places, particularly in the low troughs. In other places, such as the cache site, loess deposition outpaced pedogenesis, burying the cobble-strewn surface, and ultimately, the Richey-Roberts cache and any other artifacts on the old surface.

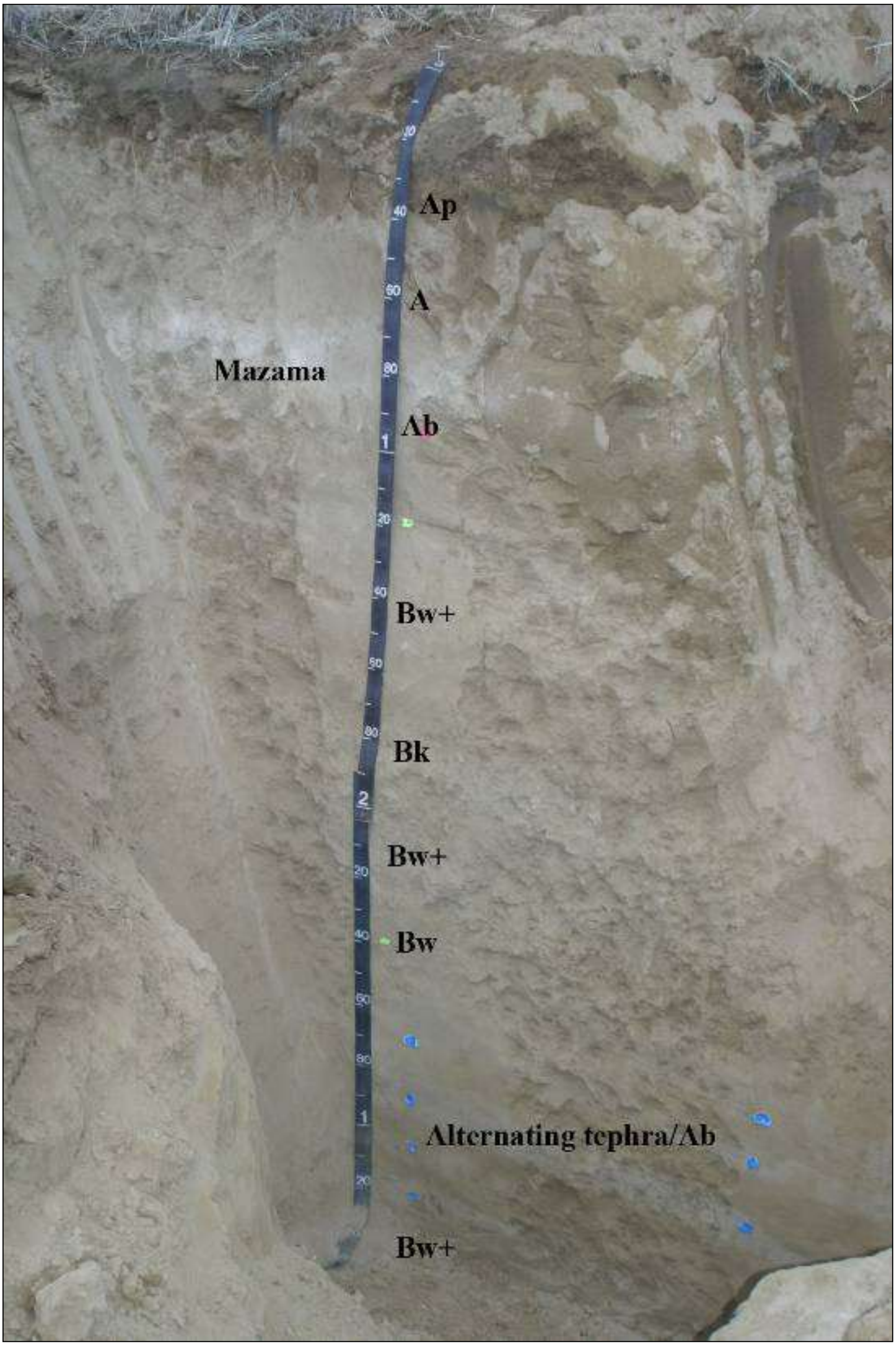


Figure 6.12 Exposure of distal alluvial fan deposits with alternating layers of Glacier Peak tephra and incipient A horizons at the base of the stack.

**Contact A**

Mehringer (1988) identified a feature in the sediment at the site as a "difference in cohesiveness that is not apparent to the eye. Yet, with a trowel it can be detected as an abrupt to diffuse boundary". I identified a similar qualitative aspect of the sediment near the base of Trench 4. This is likely a feature of pedogenesis, the precipitation of silica immediately underlying the Upper Pleistocene Glacier Peak tephra. Another weak Bkq horizon displays similar characteristics in trench 6Figure 6.13). Similarly, this phenomenon is recorded in other environments underlying Mazama and St. Helens Set S tephra, although normally it is considered the combined effect of carbonate-silicate precipitation in wetter environments like the alluvial environment at the Kennewick man site (Huckleberry et. al 1998).

Figure 6.14 displays a cross section of the Richey Roberts vicinity. To the north, the scour trench has a basal section representing a localized pond that developed in megaflood sediments. Loess overlies this feature to the surface. Glacier Peak tephra is present in the loess, capping the Bishop geosols, which is also clearly present in the northern most backhoe trenches that contain the deepened portions of the scoured trench. Southward, extending towards the location of the Richey-Roberts cache, the parent material is megaflood sediment capped by relatively coarse (sandy) eolian

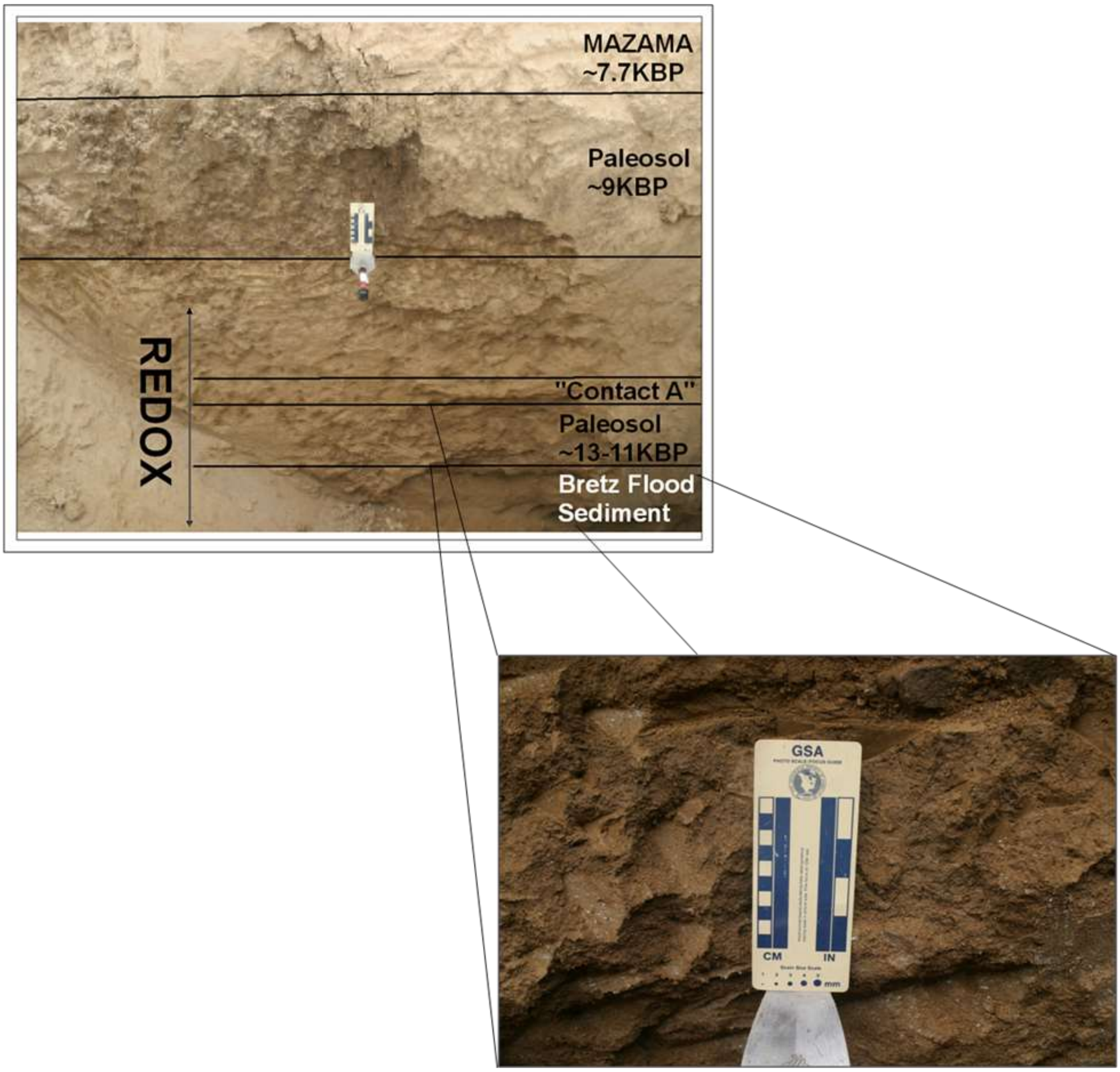


Figure 6.13 “Contact A“ at surface of Bishop geosol, Richey-Roberts site, Grant County, Washington.

sediment. The Badger Mountain and Bihsop geosols are most strongly developed in the two deepest trenches. Southward, with elevation rise on the flood bar, trench 4 included a “typical” pedon that contained very weakly. It includes a weakly cemented horizon that likely represents precipitation of Upper Pleistocene tephra (Glacier Peak), “Contact A” of Mehringer (1988). Mixed lithology rock fragments (cobble to boulder size) from the sand bar sediments are located in exposures across the megaflood bar. Termed “dropstones” in the Mehringer report, these isolated pieces of basalt float were

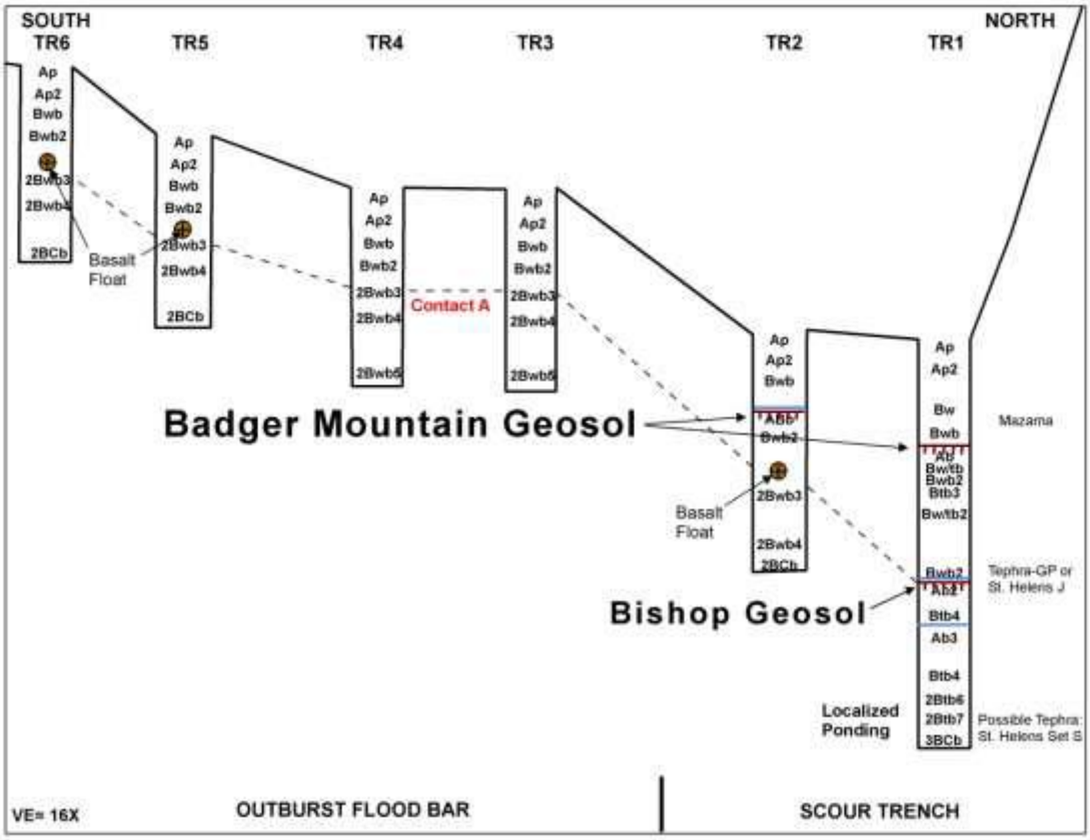


Figure 6.14 Representative cross-section at the Richey-Roberts site, displaying relationships of subsurface deposits across the project area.

deposited on the megaflood surface by the last flood to top the high point bar, at 12.8 KBP. This is the Bishop geosol surface: Glacier Peak tephra fell on this surface, pedogenesis likely precipitated silica together with carbonate, accumulating as a weakly developed Bkq horizon, now termed "Contact A". Exposure trenches 33, 43, 55,56,57,58 and 59 in Appendix 1 are part of the Badger Mountain type transect, located in proximity to the Richey site.

**Willow Lake, Washington**

I undertook stratigraphic work at Willow Lake in 2008. In terms of characterizing the site area, there are 3 primary depositional bodies of importance. 1. The valley floor has an alluvial fill with Glacier Peak tephra near the contact with the underlying water table. 2. There is an upper Pleistocene inset terrace with Glacier Peak and Mazama tephras, which comprise approximately 30% of the site area. 3. There is an Upper Pleistocene flood bar that represents late-glacial Grand Coulee flooding. All three landforms are of sufficient age and character to hold intact archaeology from the colonizer period through modern times.

The upper Pleistocene terrace, deposited during A1 times, covers a broad area, roughly 5 acres within the local basin. The basal unit is matrix-supported gravel which is overlain by gleyed sediment. A dark A-horizon of the Bishop geosol overlies the gleyed deposit. Glacier Peak tephra, indicated by very large pumice clasts sits conformably on the surface of the Bishop soil. The Bishop is buried by uniform, nearly homogenous sediment that is light in color due to Mazama tephra additions, nearly to the surface. A weak soil is forming into the surface of the terrace.

Inset into this upper Pleistocene terrace is an early Holocene terrace deposited during A2 times. The base is a black sandy loam, the Badger Mountain geosol. Overlying this, in conformable contact is a section of the Mazama tephra that is nearly 30cm thick. The Willow Lake Paleosol formed into sandy alluvium over the Mazama and a weak surface soil caps the sequence.

**Winchester Wasteway (45GR161)**

The Winchester Wasteway is a former scabland channel and is one of few sites that display classical alluvial features including a broad meander and multiple inset upper-Pleistocene terraces. I have conducted limited fieldwork in the site vicinity. The site appears to reflect a complex geomorphic history, serving originally during the scabland floods as a drainage path, and during the waning stages of glacial Lake Columbia as a waterway that partially drained water coming out of the Grand Coulee (Moses Lake is the primary waterway through which glacial Lake Columbia drained). It is possible that the Winchester Wasteway served as an “overflow” channel during very large, but not Scabland-wide floods when the Moses Lake drainage was at peak flood stage. Due to the Columbia Basin irrigation project the site now is dominated by wetland plant species, but during the drier portions of the Holocene was not likely wetted (cf. Moody, 1978; Fryxell and Daugherty, 1963). The relatively large site area and nature of the lithic assemblage indicate a possible campsite that was used repeatedly on a seasonal basis, possibly as a base for collecting raw material in the Beezley Hills just north-northwest of the locale (see Chapter 5). Given its geomorphic position on a low-lying inset terrace that was fluvially active during the upper Pleistocene, it is one of the strongest known candidates for a large colonizer period archaeological site on the Plateau.

Bedrock is Ringold formation sediment, into which Upper Pleistocene megaflood deposits were emplaced (Figure 6.15). The A1 aggradation cut and filled the megaflood sediments. Clovis people utilized these terraces which were next to flowing water during Clovis times. Clovis material was on the surface and within the upper 5cm of sediments at the site, indicating occupation either after or at the close of the aggradation period. The A2 aggradation cut and filled the A1, Badger Mountain soil lies buried in the early Holocene terrace.

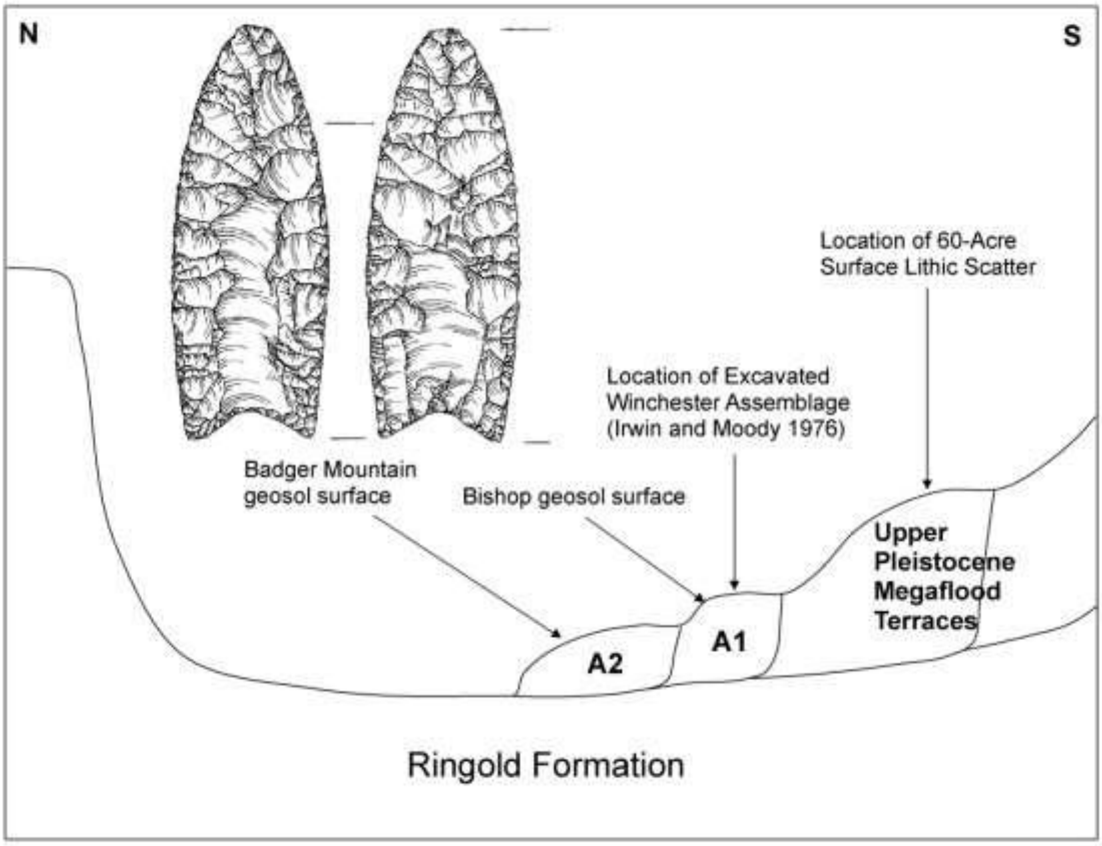


Figure 6.15 Cross-section of Winchester Wasteway Geoarchaeological Setting

**Woodhaven/Granite Falls sites-45SN28; 45SN303; 45SN360; AND 45SN417**

The terrace systems which developed in Puget Sound watersheds include two well-preserved, extensive Upper Pleistocene terraces, which are remnants of the Colonizer paleolandscape. While many of the known early "Olcott" archaeological sites are reported as existing in heavily bioturbated stratigraphic contexts, several recently discovered sites, 45SN28; 45SN303; 45SN360; 45SN417 are essentially intact, containing multiple buried soils which I interpret as correlating to the Bishop and Badger Mountain geosols. Although Olcott sites are essentially considered to be early archaic in age, I've included them in this portion of the report to illustrate the unique landform setting on which they are found. Chapter 3 outlined some detail of the isostatic terraces in the Puget Sound. Each of the sites reported here are located along the same high terrace with Pleistocene alluvial stratigraphy and strong pedogenic differentiation—features that are not commonly associated with other early Holocene recorded sites.

**Geomorphic context of the project sites and pedologic association**

In 2009 and 2010 I conducted geologic fieldwork at these sites. Sites SN28, SN303 and SN360 are located on high terraces of the Stillaguamish River. These terraces, a product of glaciofluvial meltwater deposition and isostatic rebound are highlighted in Beechie et. al (2001) and noted in Chapter 3. The sites are located at slightly different topographic elevations, a factor that has contributed significantly to unique geoarchaeological details at each of the sites.

The Natural Resource Conservation Service Soil Survey of the Snohomish County Area has assigned soil-landform associations that are useful when correlating landforms to the colonizer site areas (

Figure 6.16).  The Winston gravelly loam and Ragnar fine sandy loam in particular are correlated to Pleistocene terraces that formed in glacial outwash with mantles of loess and volcanic ash.

One aspect of forest pedogenesis west of the Cascade Range is that of Bs horizon development.  In forested landscapes, low base-cycling plants such as Hemlock have acidic organic layers which cause acid leaching.  As the acids are leached downward through the mineral soil layer, mineral salts including carbonates move out of the solum.  The resulting soil profile includes overprinted soil horizons that reflect post-depositional changes rather than horizonation that is related to primary deposition and geosol development.  Primary soils like the Bishop often appear relatively deep in the stratigraphic section as grey “mineral” horizons and are interpreted as pre-archaeological (glacial) bodies.  This has tremendous ramifications in terms of identification of colonizer period sites in forested zones and has undoubtedly caused problems in targeting appropriate subsurface horizons that might hold colonizer archaeology, at least west of the Cascade Range and in the Blue Mountains of Washington and Oregon.  While Olcott assemblages may be identified due to their shallow depth, earlier horizons, potentially spanning as much as six thousand years of cultural development could go un-noticed.

Figure 6.17 displays a stratigraphic section at 45SN303 that is common to many sections on the upper section of the colonizer terrace.  The Badger Mountain geosol surface is truncated by the Ap2 horizon.  In this profile the lower boundary of the Bs

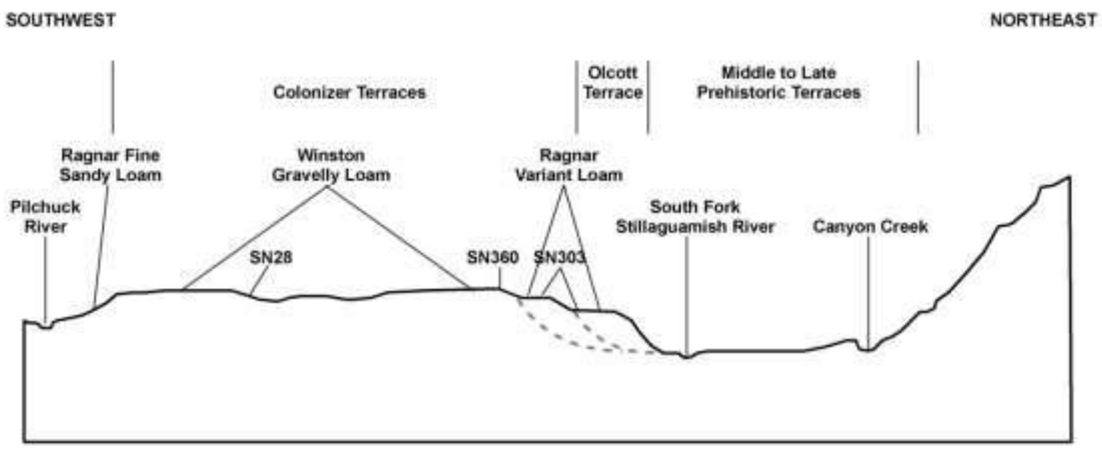


Figure 6.16 Geoarchaeological association with mapped soils, SN28, SN303, SN360

horizon overprinting varies from 60 cm to 105 cm. The pattern of faunal burrows in this section is consistent with pedostratigraphic sections on both sides of the Cascade Range. Mazama tephra fell onto the surface of the Badger Mountain geosol, burying it in many exposures. Faunal burrows are filled with mixed Mazama tephra (~7.7 KBP), indicating a significant near-surface tephra source at the time of burrowing. The underlying Bishop geosol includes both krotovina and root channels that are Mazama tephra-free, an indicator that the stable surface during their formation did not include tephra.

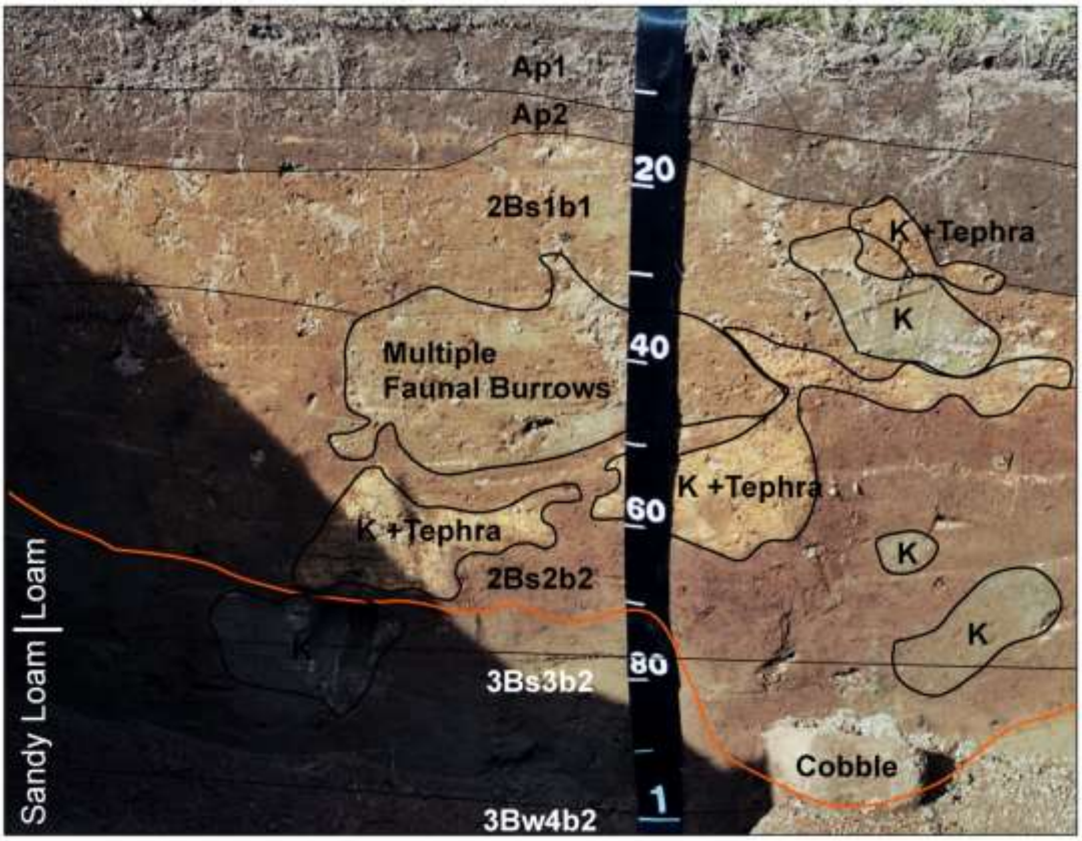


Figure 6.17 Stratigraphic profile displaying pedogenic horizons and tephra-filled faunal burrows. Bsb (sesquioxide accumulation horizon) overprinting is indicated as an irregular orange line.

The upper boundary of the Bishop geosol is consistent with a parent material change, ranging between 75-80cm. The Bishop geosol formed into glacio-fluvial alluvium, the Badger Mountain geosols formed into loess. An igneous cobble, approximately 10cm in diameter is present in the cap of the uppermost alluvial unit, also marking the Bishop geosol surface in the same way it is marked at the Richey-Roberts site. This cobble is either a manuport, or a rock that rolled or flowed as colluvium down a slope to the east of the trench, although no other evidence of colluvial deposition is present on site. Internal stratigraphic differentiation within the Bishop geosol is also indicated by moderately hard surfaces with dry consistence and loam texture with abrupt boundaries at 140 cm and 240 cm depth.

**WT2**

Nance (1966) investigated WT2, describing the stratigraphic sequence. The basal layers of WT2 are built on catastrophic flood sediment of the Scabland megafloods

(Figure 6.18). These are buried by a gravel member of the early alluvium of Hallett (1977). Sandy alluvium caps this material into which a strong, calcareous soil formed, the Bishop geosol. The stable Bishop soil surface includes a disconformable cap, which is overlain by sandy eolian material and the Mazama tephra. The sand which overlies the early alluvium and Bishop soil also has a weak soil formed into it, the Badger Mountain geosol. Overlying the Badger Mountain soil is a thin layer of eolian material which is in turn buried by an approximately 30 cm. deposit of Mazama tephra. An early Holocene radiocarbon date was taken from cultural Level D which overlies the Badger Mountain soil, but underlies the Mazama tephra. Cultural Level C artifacts were recovered in the Mazama tephra, suggesting some mixing by bioturbation. This, together with a disconformable radiocarbon date of 7.3 KBP underlying the 7.7 KBP Mazama tephra, suggests that the Mazama tephra may be in secondary context, redeposited after the primary eruption (Nance 1966, Table 1). Nonetheless, deposition between the two buried soils is similar to stratigraphic sections I describe from the Richey site below. If these basal soil is indeed Bishop geosol, then the sediment which buried it formed during the Younger Dryas period.

**Discussion**

Geoarchaeological studies in the Pacific Northwest are often focused on site-specific questions of depositional context, site formation and post-depositional processes. Of course, these are the “bread and butter” studies of Geoarchaeology. Broader characterizations of Pacific Northwest regional depositional systems applied specifically to archaeological site locations are necessary in order to move forward with targeted research on issues related to the earliest inhabitants of the region, which may relate directly to the broader colonization of the Americas.

Bishop Spring, Badger Mountain, BPA springs, Lind Coulee, Richey-Roberts, Sentinel Gap, Willow Lake, and Winchester Wasteway are Columbia Plateau locations that contain Pleistocene sediments, are located away from the modern river floodplain, and have all produced colonizer artifacts. Other locations with high potential exist in similar environments and need to be archaeologically tested. West of the Cascade Range, colonizer surfaces exist high on the isostatic terraces, well away from modern river courses and beach fronts. Recognition of buried time-stratigraphic horizons such as the Bishop geosol are critical to recognize in these environments, so as to adequately sample the subsurface for colonizer archaeology.

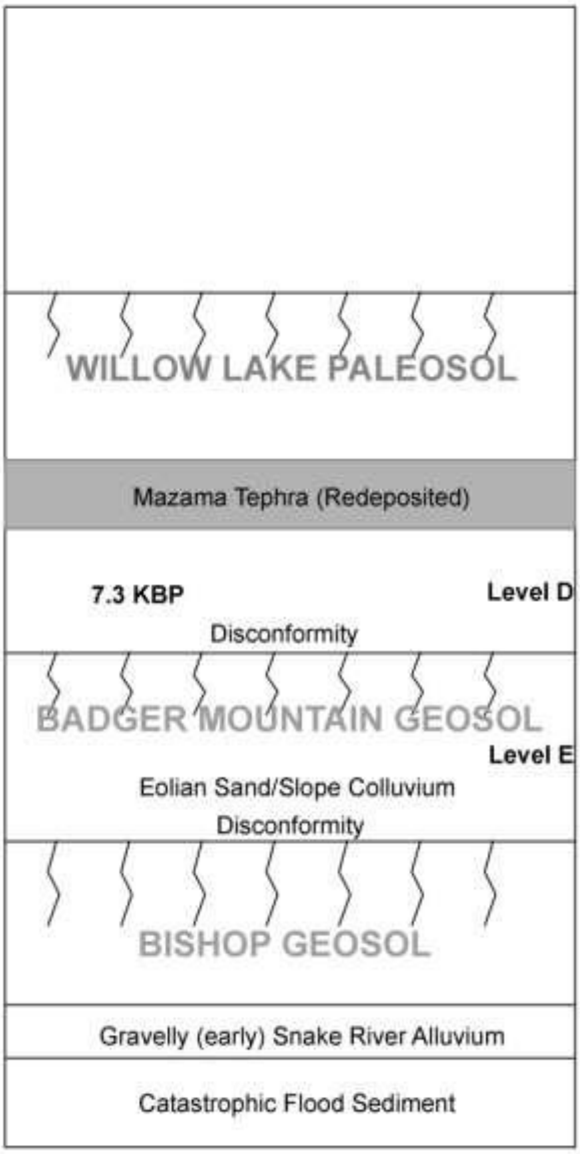


Figure 6.18 Schematic stratigraphic section, WT2; Note sediment overlying disconformity, separating the paleosols. Date from Nance 1966, Table 1.

## CHAPTER 7
## CONCLUSION

### Introduction

Feld rearchers can maximize potential for Colonizer site discovery if we stratify the landscape by applying geoarchaeological methods into the discovery process, a point which has been one focus of this dissertation. The final chapter presents a summation of the key points of this work in the form of a broad model that is first summarized, and then discussed in closing. I examine my original goals and hypotheses, then demonstrate how they were addressed and answered in the text. But before summarizing, it is important to re-emphasize a key principle behind this research, the concept of *geoarchaeological potential*.

Before geomorphic, pedogenic and stratigraphic models can be applied to archaeological site discovery, it is important to cover the higher level theory of the potential of a given landscape to hold sites of any age, let alone colonizer age sites. To begin, it should be intuitive to most researchers that there is an overall very low potential for buried sites to exist in landforms dating from the Last Glacial Maximum and earlier; these geologic contexts, at least within the post-glacial maximum colonization paradigm, are simply too old to contain buried archaeology. Conversely, archaeology which dates to ALL subsequent time periods may be located within or even on the surface of the same deposits. On the other hand, the potential for discovery of buried archaeological material within early Holocene landforms is much more likely, and this is exactly what we find when we examine the record of known Colonizer sites.

Upper Pleistocene landforms can only contain buried sites dating to the Upper Pleistocene period (Colonizer sites). Still, Pleistocene landforms have relatively low potential for containing buried cultural resources of the period if for no other reason than the overall population density at the upper Pleistocene was low and the corresponding period of time which people were able to use the landform is relatively short when compared to the entirety of the Holocene.

Similar logic applies to all subsequent Holocene landforms. Generally speaking, as the age of the landform becomes older, the likelihood that buried archaeological material will eventually be discovered on or within the sediment package increases. This results from two factors: (1) Post LGM landforms throughout the region contain soils and other time-stratigraphic and rock-stratigraphic horizons which aid in understanding the relative age of archaeological deposits (volcanic tephras and the regional geosols, the latter of which represent former stable surfaces on which colonizer activities took place) and (2) Although population densities likely waxed and waned through time, the trend throughout the Holocene was a tendency towards higher population densities, so that potential landscape use and sheer number of artifacts created and used by prehistoric people should also tend to increase, at least until European contact when epidemics wiped out the native populations. Together, these form a simple, linear relationship between landform age and archaeological potential which allows us to hypothesize which landforms have potential to yield buried cultural resources related to established chronological units, which landforms have potential to yield artifacts in the near surface to surface, and which do not (Table 8.1).

Table 8.1 Relationship of Cultural Chronological Units to Archaeological Site Probability based on Landform Age (Culture chronology based on Chatters 1998).

| CHRONOLOGICAL UNITS | LATEST PLEISTOCENE LANDFORMS | EARLY HOLOCENE LANDFORMS | MIDDLE HOLOCENE LANDFORMS | LATE HOLOCENE LANDFORMS | PROTOHISTORIC TO PRESENT |
|---|---|---|---|---|---|
| Colonizer/Early Period | High Potential for Archaeology | No Potential for Archaeology | No Potential for Archaeology | No Potential for Archaeology | No Potential for Archaeology |
| Early Middle Period | Potential for Archaeology | High Potential for Archaeology | No Potential for Archaeology | No Potential for Archaeology | No Potential for Archaeology |
| Late Middle Period | Potential for Archaeology | Potential for Archaeology | High Potential for Archaeology | No Potential for Archaeology | No Potential for Archaeology |
| Early Late Period | Potential for Archaeology | Potential for Archaeology | Potential for Archaeology | High Potential for Archaeology | No Potential for Cultural Resources |
| Middle Late Period | Potential for Archaeology | Potential for Archaeology | Potential for Archaeology | High Potential for Archaeology | No Potential for Cultural Resources |
| Late Late Period | Potential for Archaeology | Potential for Archaeology | Potential for Archaeology | Potential for Archaeology | High Potential for Archaeology |
| Protohistoric to Present | Potential for Archaeology | Potential for Archaeology | Potential for Archaeology | Potential for Archaeology | High Potential for Archaeology |

**Application of Regional Pedology to the Geoarchaeological Model**

I have provided overviews of geomorphic and depositional systems of the Pacific Northwest region with a focus on how they relate to the regional archaeological deposits. But the heart of the geoarchaeological model presented here would be minimally worthwhile without the inclusion of the regional geosol sequence. Paleoenvironments at the Pleistocene-Holocene transition were especially conducive to the formation and preservation of these soils.

Based on observation of profiles in this work it is clear that the close of the Pleistocene was marked by extreme climatic fluctuation. Effective moisture was initially high, but rapidly waned as is evidenced by redoximorphic soil features in stratigraphic exposures across the central interior Columbia Plateau (Huckleberry et. al 2003; this work). The Bishop geosol formed into sediment that was deposited prior to the eruption of Glacier Peak tephra, under significantly wetter conditions. Cicadas were active during this time and into the early Holocene. With the onset of the Younger Dryas the regional water table dropped. In the forming Badger Mountain geosols, cicada burrowing waned as warmer, drier conditions prevailed. Earliest Holocene sediments are marked by carbonates developed into the Badger Mountain geosol as the thermal maximum reached its apex. Sediment depositon waned and a significant buried A horizon formed at the paleosurface. On most of the mainstream and tributary drainages, soils formed on recently isolated terrace steps, abandoned by Upper Pleistocene and early Holocene incision. The eruption of Mt. Mazama marks the end the soil formation as it buried the Badger Mountain and Bishop geosol sequences.

West of the Cascade Range geosol development has a different character. Typically, researchers consider these forested environments to be heavily disturbed by bioturbation—and in many situations they are. But even in forested settings with high potential for bioturbation, the macro-scale geosol fabric is observable and its characteristics are clear; research at the Woodhaven and Granite Falls sites (Chapters 2 and 6) are excellent examples of the apparent juxtaposition of competing processes in these bioturbated paleosurface horizons.

Even so, teasing numeric dates from these environments is exceedingly difficult as the effects of low-base cycling plants on radiocarbon dating, coupled with common, intrusive burned evergreen roots from late Holocene times are pervasive. What is clear though is the preservation of soil properties indicating the presence of the geosols. For now, geosols located in environments west of the Cascade Mountains can only be dated by relative position (underlying the Mazama tephra) and by extrapolation of our understanding of stratigraphic occurrence of the geosols east of the Cascade Range (Badger Mountain over Bishop). Recent work by Matsumoto et al. (2007) with AMS radiocarbon dating of fatty methyl-esters, particularly the longer chain fatty acids from plant leaf wax, may be extremely helpful in understanding these forested soil sequences as the datable fossil leaf wax is maintained in soil without serious degradation due to its hydrophobic properties. It is reasonable to assume that, given the in-situ preservation of pedogenic horizons, leaf wax from pre-forested times may exist. Further testing and more careful excavation and sampling of these basal geosol deposits with targeted geoarchaeological work is necessary.

Another key point of importance that should be restated here, is my presentation of a new date for Mt. St. Helens Set S tephra based on radiocarbon dating of bone collagen. In so many places across the interior Pacific Northwest the Mt. St. Helens Set S tephra is present at the base of sediment deposits with archaeological potential. As such it is a critical time-stratigraphic marker horizon for all disciplines that apply tephrochronology to their interpretations, especially so with Paleolithic archaeology.

The discovery of an extinct form of Mountain Sheep that was clearly killed by a megaflood and deposited between layers of Mt. St. Helens Set S tephra is fortunate. What is especially fortunate is that I happened to walk through the drainage cut at exactly the right moment to recover the fossil within days before it would have eroded completely in to the drain. This new date, 12,800±60 (CAMS 59589; Table 3.6), is consistent with earlier estimated dates that hovered around 13 KBP.

Having reiterated the baseline theoretical concept of archaeological potential and presenting details of the newly identified stratigraphic markers and their relationship to Colonizer archaeology, I move now to a practical application: summarization of details that together contribute to the development of a regional geoarchaeological model of Colonizer site potential.

**Presentation of the Geoarchaeological Model: Analysis of Known Sites**

Meltzer (2004) has pointed out that the majority of research related to colonization of the Americas has focused on finding <u>things</u>—in particular, projectile points, the "oldest" archaeological sites etc. My dissertation research effort is meant to be a departure from that focus. I've attempted to consider the underlying context of the landscape at the end of the Pleistocene, what signature environmental aspects signal locations colonizers may have lived, and ultimately, where we might find evidence of their adaptation to the landscapes of the Upper Pleistocene Pacific Northwest. Figure 8.1 presents a graphic (schematic) representation of geoarchaeological site attributes which are summarized as narrative statements below.

**Geoarchaeological Similarities at Known Colonizer Sites**

Inter-site comparisons of geoarchaeological detail represented by sites in Figure 7.1 demonstrate that ALL colonizer site locations witnessed periods of soil formation during which the sites were occupied. Simply put, there is a 1:1 correlation between colonizer period sites and the Bishop and Badger Mountain geosols identified in this work. While each site expresses this relationship unequivocally, there are some points of note that are key. The broadest similarities among known Colonizer sites include recurrent, coupled pedogenic/tephra sequencing. This should be intuitive, as the same process that is conducive to soil formation—a significant hiatus in deposition that allows biological processes to outpace sediment accumulation—is also conducive to the preservation of airfall tephra. Essentially, the land surface is stable for an extended period of time (thousands of years) and the volcanic ejecta fall onto that ground surface. Once sedimentation rates increase again, the soil and tephra package are buried and preserved. The process that lead to this sequencing occurred twice, first

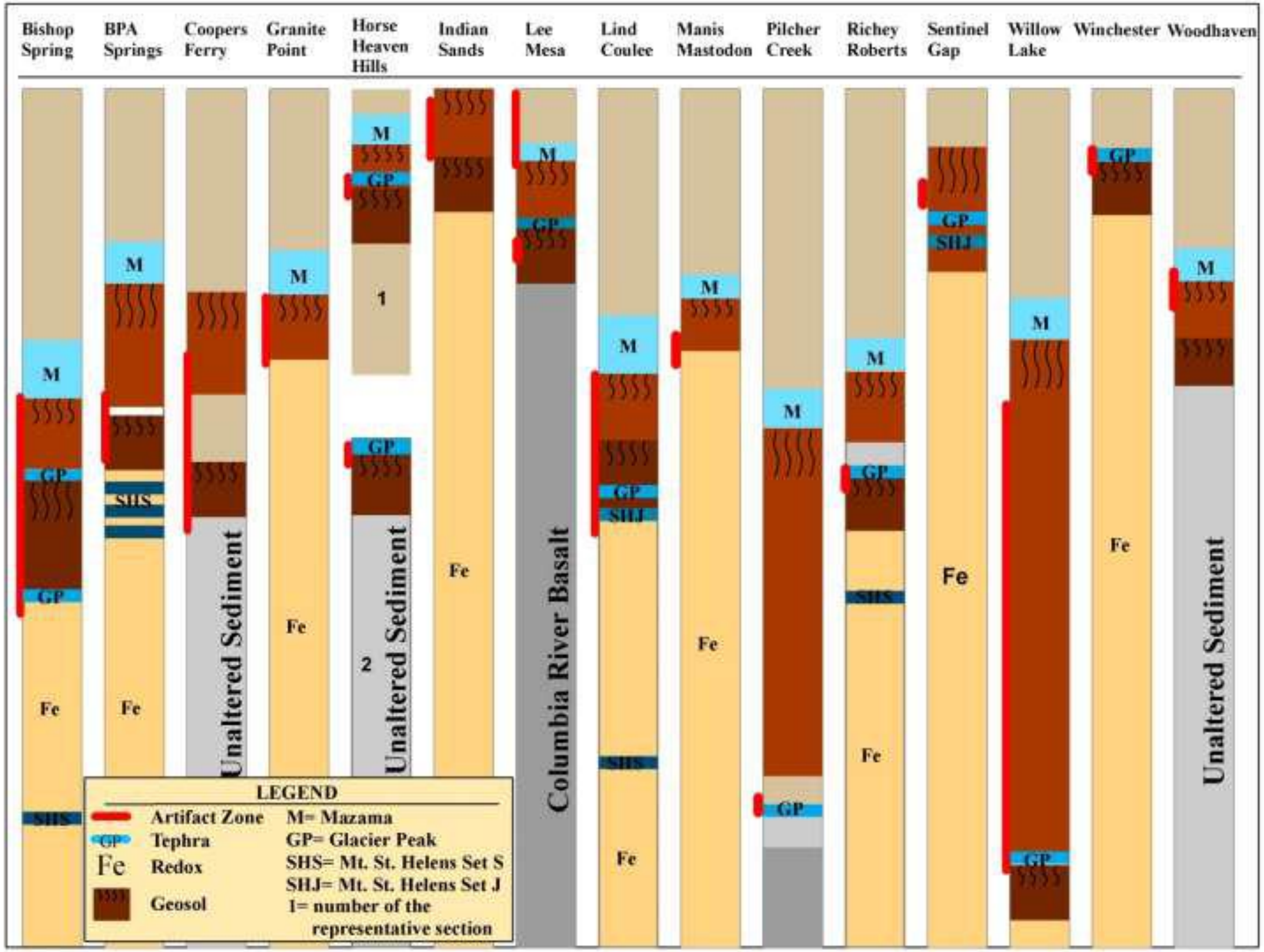


Figure 7.1 Geoarchaeological Detail at Known Colonizer Sites

with the Bishop geosol, which was capped by Glacier Peak and Mt. St. Helens Set S tephras, and last with the Badger Mountain geosol which was buried by the massive eruption of Mt. Mazama.

Most of the Colonizer sites include basal sediments that have undergone pedogenic redox, indicative of a fluctuating water table as the Pleistocene gave way to the much drier, hotter early Holocene period. Similarly, BPA Springs, Horse Heaven Hills, Richey Roberts and the Pilcher Creek sites display soils that are truncated by an Early Holocene interval of erosion, also reflecting the transition to the progressively warmer and drier climate.

The fluted point sites, Richey Roberts and Winchester Wasteway, both include a deposit of Glacier Peak tephra which fell onto the Bishop geosol surface at a time slightly prior to the established age range of Clovis (Waters and Stafford 2007). The sequence at Bishop Spring, BPA Springs and Lind Coulee share every detail, beginning with deposition of the Mt. St. Helens Set S tephra at the end of the megaflood sequence, multiple periods of pedogenesis and tephra fall, closing with the burial of the entire sequence by an extended late Holocene surface sediment stack.

In shallow depositional environments (Indian Sands), on flow-restricted, shallow lithisols (Lee Mesa) and on Upper Pleistocene terraces (Horse Heaven Hills, Winchester Wasteway), the Badger Mountain geosol is welded onto the Bishop geosol or older soils.

**Geomorphology and Depositional Environments of the Known Colonizer Sites**
In the broadest view, the landscape evolution of the known Colonizer sites is similar, recorded in the regional geologic sequences as synchronous alluvial and eolian depositional cycles punctuated by long periods of pedogenesis. Across the region the glacial melt resulted in mega discharge, causing widespread resculpting of the landscape and realignment of drainage systems subsequent to the melting; Initial occupations of the region correspond with the initiation of braided stream systems apparently prior to 13 KBP. Post-Pleistocene alluviation on the primary regional drainages took place in a relatively narrow trench, much smaller than the initial post-glacial drainage system, leaving Colonizer sites either deeply buried, or more often than not, isolated along the former braidplains and ancestral drainages that are now far from the modern rivers. This situation has led to errors of sampling that have seriously retarded our understanding of early man.

This region-scale analysis of Colonizer geoarchaeology explored the contexts of Upper Pleistocene through Early Holocene landscapes. While exceedingly few sites from this time period are known, many must be preserved, either deeply buried or in settings that are not as aggressively developed, hence likely to intersect Colonizer sites as the later Holocene to modern landscapes. Due to the limited Colonizer site sample it is only possible to derive a fledgling understanding of *specific* environments used by early peoples. It is, however, possible to develop a geoarchaeological model of the Colonizer landscape, human settlement, and archaeological site preservation potential based on mature geologic and paleoenvironmental data exclusive of known site data. Such a model is linked to geomorphic zones characterized by dynamic glacial, alluvial and eolian depositional systems that were stabilized by periods of soil formation and on whose surfaces occupation must have concentrated.

The majority of known colonizer sites often lie in what now are relatively poor habitats, at least as far as human carrying capacity is concerned and where middle to late Holocene sites are rare. Based on geoarchaeological data, these same locations were prime for exploiting streamside and lake/marsh resources and hunting in mid-to low-elevation grasslands. These include lowland settings associated with pluvial lakes (along the margins of the larger coulees) or marshes (on the coulee floors and drainages), elevated old surfaces on valley margins where megaflood-induced giant lakes persisted or along Pleistocene river and stream terraces of the A1 and A2 aggradations. The patchy mosaic of small marshes across the central portion of the Columbia Plateau would have provided plants and seeds, waterfowl eggs and fish. Both small and large mammals would have utilized the marsh environments.

Large-scale archaeological surveys in the Pacific Northwest region have tended to focus on areas of significant modern development, such as coastal population centers, and the large river valleys where hydroelectric development has occurred. Neither of these environments tends to contain geologic deposits of appropriate age to hold Colonizer period archaeology. In those situations where sediments or landforms of appropriate age do exist, there are few focused geoarchaeological studies that have identified the appropriate contexts in which to search. To many researchers, even those with decades of experience, “Old dirt” still just looks like dirt. In the absence of time-diagnostic artifacts, many colonizer sites will go unrecognized. To the contrary, many ancient environments outside these developed corridors are available for research that has high potential to yield colonizer archaeology. Upland settings, where isostatic rebound has lifted Pleistocene beaches and coastal zones well above the modern shoreline, outer coastal areas that are well shoreward of the continental shelf and ancient alluvial environments that are far from the later Holocene floodplains where active development takes place are highly likely locations for colonizer archaeology to be found.

A large area of focus in the interior Columbia Plateau has exceedingly high, proven potential for early archaeology. These are the Scabland corridors that contain buried Pleistocene landscapes beneath vast expanses of undeveloped land. In these environments, glacier-proximal lakes occupied Pleistocene valley floors, and late glacial alluvium created valley fills; these are the environments that will contain Colonizer period archaeology. While a handful of colonizer sites are known from these environments, focused new research is necessary in order to continue the development of colonization models for the region and outward.

**Summation of the Colonizer Geoarchaeological Model**

When considered in light of the hydrogeologic settings that exist in scabland tracts of the Columbia Plateau and the uplands of the Puget Sound subregions, the recurring geomorphic, paleoecological and stratigraphic records there can aid in the location of Pleistocene archaeological sites (Figure 7.2). In addition to pedogenic-geologic sequencing present at all of the colonizer sites, certain geomorphic and hydrogeologic features are successfully correlated with the few Colonizer sites that are known:

In lowland settings, colonizer sites are found:

(1) On scoured and denuded bedrock adjacent to fluvial deposits;

(2) At extinct paleolakes and remnant landforms associated with high stands of these bodies of water;

(3) On alluvial terraces within scabland flood channels which formed as the result of post-flood dewatering and subsequent upper Pleistocene–earliest Holocene alluviation.

(4) Many colonizer sites are located in shallow groundwater environments; The Pacific Northwest region emerged from the post-Wisconsin glacial retreat in paleogeography that was transformed not only by direct action of the ice-land contact, but even more so by the effects of the volume of meltwater it produced, the influx of parent material into the regional alluvial depositional systems and the rebound of the landscape from the weight of the ice body; Colonizers utilized the former meltwater pathways and drainage-proximal landscapes.

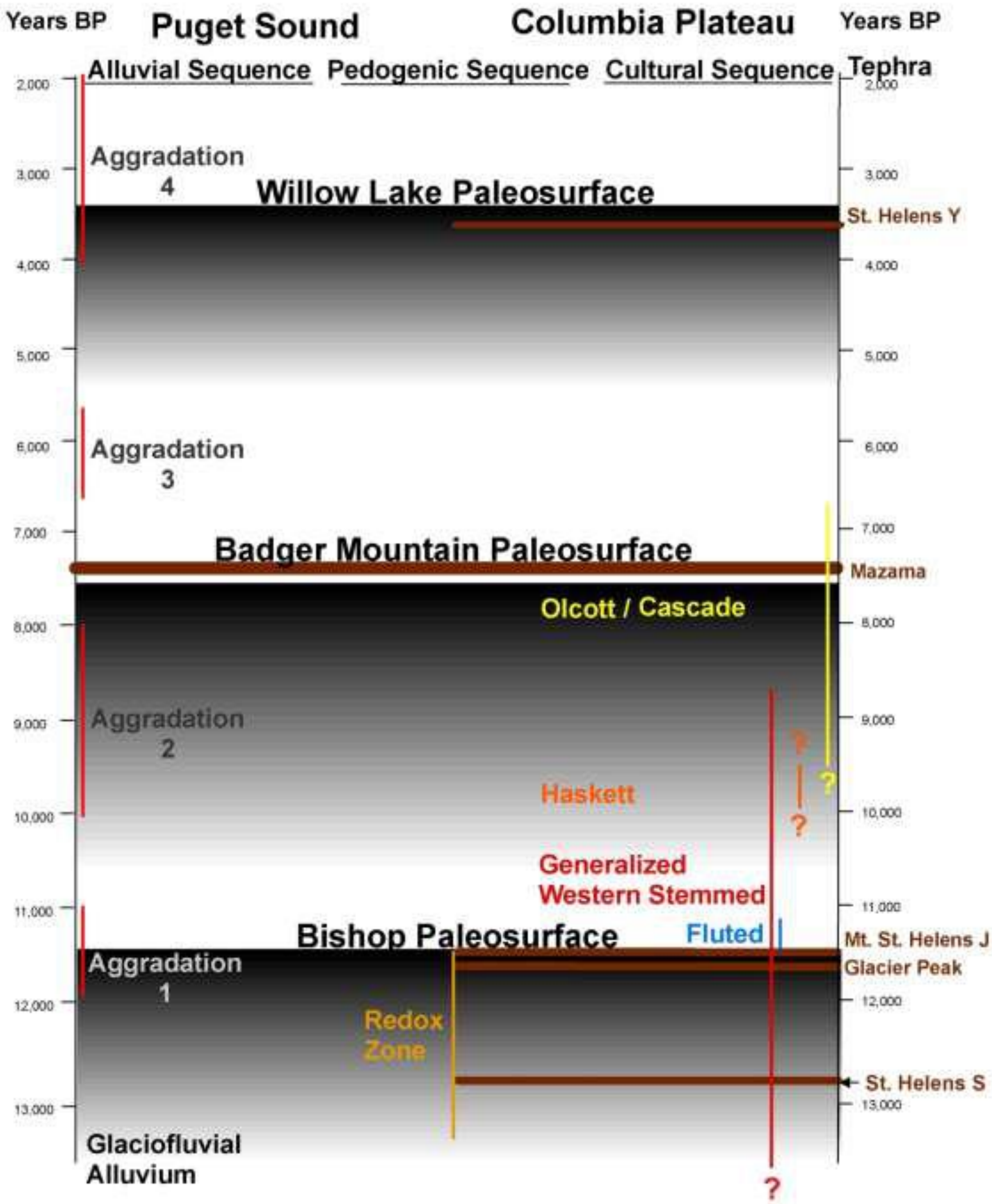


Figure 7.2 Geoarchaeological model displaying Pacific Northwest soils, alluvial cycles, culture chronology and tephrochronology. Redox= redoximorphic soil features.

In upland settings, colonizer sites are found:

(5) Where isostatic rebound has lifted Pleistocene sediments well above the modern shoreline;
(6) In environments that are shoreward of the continental shelf;
(7) In environments that are shoreward from the later Holocene floodplain environments where active development takes place;
(8) Within Scabland corridors along the former path of Missoula flooding. These tracts contain buried Pleistocene landscapes across expanses of undeveloped land;
(9) Where glacier-proximal lakes occupied Pleistocene valley floors
(10) In the interior Plateau buried in valley fill along the coulee bottoms
(11) Many colonizer sites display evidence for a high, fluctuating water table during the close of the Pleistocene but prior to deposition of Mazama tephra and in many places lie adjacent to or within marsh settings;

While the correlations above are compelling, they are drawn from an exceedingly small sample. Given this, it is worthwhile to add another dimension to the extrapolated geoarchaeological model. By harnessing existing data we are able to derive a set of baseline conditions necessary to identify the environments where we are likely to find Colonizer sites at some future time—or at least where there is clear archaeological potential for them to exist. In order to accomplish this it is necessary to summarize key landform and stratigraphic relationships identified with some detail in the prior chapters, although at a more generic level. The following points present landscape-scale generalizations that are based on this dissertation data. The principal pedogenic, geomorphic and paleoenvironmental settings associated with Colonizer period landscapes of the Pacific Northwest region may be summarized as follow:

1) Two regional soils which bracket the Colonizer period are present across the Pacific Northwest region. These soils represent the paleolandscape that Colonizers utilized.

a) The Bishop geosol formed between 13 and 11.6 KBP. Mt. St. Helens Set S tephra (12.8 KBP) is often present at its base, Mt. St. Helens Set J tephra (11.6-11.8 KBP) fell onto the Bishop surface.

b) The Badger Mountain geosol formed between 10 and 7.7 KBP. It is characterized by carbonate accumulation, concentrations of fossil cicada burrows and disseminated charcoal. The Mazama tephra (7.7 KBP) fell onto the Badger Mountain geosol paleosurface.

2) There is considerable discordance in the upper Pleistocene to early Holocene geomorphology in the Puget Sound subarea of the region, attributable to the interplay of sea-level rise and post-glacial isostasy on the alluvial floodplains and along shore-proximal areas;

3) The degree of discordance within the region and between local environments is ameliorated by the Early Holocene (Badger Mountain times), when the pedostratigraphic and alluvial records tend towards regional concordance;

4) The close of the Pleistocene is marked by a fluctuating water table, evidenced by redoximorphic soil features which formed at or near the paleosurface of the Bishop geosol horizon.

5) The Pleistocene-Holocene transition is marked by stabilization of river base levels as glacial braided stream systems gave way to Holocene meandering systems and lateral accretion regimes;

6) Although local variation is present, it is possible to identify large scale regional

alluvial cycles based on time, rock and pedo-stratigraphic characteristics:

(a) Upper Pleistocene (11->12 KBP);

The Bishop geosol formed into the alluvial surface; some exposures include Mt. St. Helens Sets J, S and Glacier Peak tephras; during this time, pedogenesis kept pace with deposition; stream downcutting terraced the floodplain post 11 KBP

(b) Early Holocene (10->7 KBP);

The Badger Mountain geosol formed into the alluvial surface; Mazama tephra fell onto the floodplain surface; deposition outpaced pedogenesis at the end of the alluvial cycle in some places; a disconformity in the sequence formed prior to Mazama

deposition in some sections

7) In the uplands, data from many stratigraphic exposures suggest a Younger Dryas-age (ca. 10-11.2 KBP) period of eolian deposition with burial of the Bishop soil by clean (relatively free of pedogenic alteration) sediment in source-proximal depositional basins.

**Summation of initial research queries formulated in Chapter 1**

The goals for this research included a handful of "baseline" geoarchaeological questions and modes of inquiry. In pursuit of this primary goal, four research strategies were designed and carried out: (1) delineation of landscape change through analysis of geologic and corollary studies; (2) identification of and new definition of regional soils stratigraphy; (3) analysis of critical variables and suggestion of colonizer adaptive strategies; and (4) development of a methodology based in geoarchaeological methods for predicting and identifying colonizer archaeological sites. This dissertation describes the results of these research strategies.

The first is related to landscape transformation since the Upper Pleistocene. I posed the question, "To what extent has the landscape changed over the past 15,000 years, and how has that change affected our ability to identify Colonizer period archaeological sites? To approach this question, Chapter 3 outlined a variety of depositional systems that have literally transformed aspects of the regional landscape. Loess rain, megaflooding, glacial advance and retreat, isostasy and sea-level rise have each in unique ways led to vastly different modes of landscape use.

Given the extent of Pleistocene to Holocene landscape evolution described here, it is not surprising that the known record of latest Pleistocene and early Holocene human occupation in Washington State is sparse. This situation is undoubtedly made less clear by lower human population densities and the generally lower probability for archaeological visibility in these earliest time periods. Further compounding this situation, it is likely that the failure to locate early archaeological components of the colonizer period is directly related to the inability of regional archaeologists to identify and sample geological contexts which hold these sites and to apply appropriate subsurface methodologies for their identification.

**Soils and other time markers**

My next mode of inquiry was to address the question of whether or not buried soils or other time-stratigraphic markers representing colonizer-age landscapes are preserved in the region, and if so, where? The answer to this is a resounding "yes", and Chapter 4 provides details of their character and occurrence. In the Pacific Northwest region, ancient soils have formed into stable land surfaces across nearly every depositional environment. Soil distributions are patterned by the depositional, climatic and hydrologic systems that led to their formation and when they are mapped across the landscape, they have potential to inform landscape-scale models of archaeological potential. When the rate of soil development is able to keep pace with the rate of deposition at a given location, a soil will remain at the land surface. When the soil development: deposition ratio falls out of balance, soils become buried, forming a buried soil surface or paleosol. Because soils represent formerly stable land surfaces that were often used by humans, these paleosols have much higher than average potential to contain buried archaeological material.

Certain characteristics of soils are affected by humans. Intensive land use by groups of people may lead to compaction of the soil surface, which is manifest along the areas of densest prehistoric population as platy soil structure. Humans also create a large amount of organic waste in the form of garbage, which is recognized in a soil column by significant increases in soil phosphorus. Understanding these simple aspects of soils properties, particularly when they are tied to a strong chronologic scheme, are invaluable tools for regional archaeologists to recognize buried Colonizer surfaces, even in the absence of artifacts.

Organic soils are often representative of lakes or wetlands that have been filled or whose water source was otherwise cut off. These soils form under hydric conditions and may also be accompanied by peat or muck deposits in wetland settings. Generally, these areas are rich in biota and (especially) in areas of lower precipitation may be associated with archaeological sites. Preservation of normally perishable archaeological materials may be particularly good in soils that formed under hydric conditions. The archaeological site at Lake Ozette is an excellent example of a site whose artifacts are preserved in a nearly perfect state after burial and preservation in hydric conditions. Bishop Spring (Chapters 2 and 6) is reported to have pieces of wood recovered from the early levels (Russell Congdon, personal communication).

### Critical Variables

The next mode of inquiry I proposed was related to understanding the critical variables required to analyze the process and details of colonization at a regional scale. I pointed out early in this work that understanding the route of entry that colonizers utilized is fundamental to colonizer studies. McLaren (2008) provides details of Upper Pleistocene outer coastal zones which suggest that coastal areas were deglaciated relatively early in the deglacial process. Given this, and given the primary hypothesis that a coastal route of entry is the only viable means of colonizing the New World, these deglaciated areas must have been within the migration route of colonizers who made their way from Asia into the Americas (Fladmark 1979). McLaren also points out that there is a lack of archaeological evidence to support this hypothesis. I submit that even so, especially in light of the difficulties I've emphasized in this dissertation regarding identifying colonizer sites, the coastal hypothesis is still the simplest explanation. Discovering colonizer sites along the outer coastal zones is inevitable; all that is required is persistence, adequate strategies, and more than both of these together, time.

The research that is now taking place on the coast is significant. Three archaeological sites on the northern Northwest Coast have archaeological deposits that date prior to 10 KBP: On-Your-Knees Cave on Prince of Wales Island (Dixon 1999), and K1 and the Haida Gwaii caves (McLaren 2008). Investigations of drowned shorelines on the Hecate Strait recovered an artifact from a depth of 50m (Fedje and Josenhans 2000; Fedje et al. 2004). On the southern Northwest Coast, reported in Chapters 2 and 6 in this work are the Manis Mastodon (Gustafson et al. 1979) and the Indian Sands sites (Davis and Schweger 2004).

In addition to focusing on when people moved into the area, given the apparently rich biotic productivity of certain landscape elements (pluvial lakeshore, spring and seep environments), a corollary avenue of inquiry to this dissertation may be related to WHEN people chose to move away. Although colonizer archaeological materials are present in the region, to date, they do not exist in sufficient quantity to suggest that people stayed at any one locale more than a relatively short time. Stacked, successive archaeological deposits make it clear that they did return to the same areas though, at least until the climate began to change with the onset of the Holocene. By the middle Holocene, most formerly wet, upland, littoral landscapes had long become arid, supporting only desert-adapted plants through the majority of the Holocene. This drastic landscape evolution changed the nature of forager land use. The landscape focus shifted to the rivers where the deeply entrenched floodplains provided stable environments for the shift towards sedentism, which is a hallmark of the late Holocene prehistoric cultures of the Northwest.

**Future Research**

Several areas of targeted future research needs are clear if we are to advance our understanding of regional to continent-wide colonization. First, the regional pedostratigraphic situation needs to be further refined. I have presented a regional stratigraphic framework that provides significant new concepts in regional Quaternary stratigraphic studies. Focused, new research should seek to refine the geosols in terms of their areal extent, understanding of their age, a deeper characterization of how they are expressed across different sedimentary environments and if they can be further subdivided into subregional pedostratigraphic members.

Our new understanding of the location of relict Pleistocene beaches far from the modern coastline should be applied to new, targeted site identification efforts. In the realm of cultural resource management, the most practical field to apply this knowledge, an attempt to recognize potentially old landscapes should steer research designs, rather than focusing survey efforts based on our understanding of the general location of the highest site concentrations—which are dominated by late Holocene sites. This requires a paradigm shift away from predictive models that are based on known site locations to models that are focused solely on early archaeological potential via delineation of the landform age. Applying the geosol framework presented in this dissertation is critical to this goal. In the realm of pure research, Masters and PhD level students should target specific landforms and undertake comprehensive subsurface sampling efforts at a much more fine-grained scale that is not likely reasonable for cultural resource management. New data that is created by these surveys can then be applied to existing GIS-based models to refine how we look for early sites.

In the Scablands of the central interior Columbia Plateau, topographic lows containing water sources that are recharged by the regional irrigation project (and that mimic upper Pleistocene environments) should be intensively searched for Colonizer sites.

**Conclusions**

Archaeological geology is an interdisciplinary field of research, drawing from multiple subdisciplines of earth science, from soils to geomorphology to bedrock geology. Individually, each of these disciplines is able to address specific aspects of individual sites. Together, these lines of inquiry can bring focus to broader research problems and provide steering for future research into specific archaeological themes. That has been the goal of this dissertation research.

The focus of this dissertation research was successful in demonstrating several key aspects of Pacific Northwest Archaeology. First, the landscape of the region has changed dramatically since the close of the Pleistocene. While this is not exactly a revelation to professionals of the region, explicitly defining the nature of the change is a valuable exercise, if for no other reason than to stand as a reminder that we must view the distant past within its own context, not through the lens of the modern environment. The broad analysis of subsurface survey practices is an excellent example of our need to apply appropriate methods of inquiry to archaeological inventory research designs. Archaeological materials that are located on the surface, in the majority of instances, reflect relatively recent landscape use. With regard to the identification of Colonizer archaeology; even if subsurface testing is applied, if the target depths do not reach the Colonizer horizon, the effort is wasted.

I’ve identified geoarchaeological patterns that are correlated to known colonizer sites. I’ve also attempted to identify broad environments that are likely to hold colonizer archaeology and geomorphic and stratigraphic details of their environments of deposition. I consider this an important step in the process of identifying early archaeological manifestations in the region. But until targeted research is undertaken to specifically locate these paleolandscapes, Colonizer sites in the Pacific Northwest will remain elusive.

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