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Stratigraphy and Site Formation at the Sanders Site (45 KT 315), Kittitas County, Washinton

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STRATIGRAPHY AND SITE FORMATION AT THE SANDERS SITE (45 KT 315),

KITTITAS COUNTY, WASHINGTON

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by

James W. McLean II

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CENTRAL WASHINGTON UNIVERSITY

Graduate Studies

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ABSTRACT

STRATIGRAPHY AND SITE FORMATION AT THE SANDERS SITE (45 KT 315),

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The Sanders site (45KT315) was excavated in 1971 and 1972 by Central Washington State College under the direction of Dr. William Smith, then Associate Professor of Anthropology at CWSC. A total of 88 1 x 1 meter units were excavated up to 270 cm below surface. During the initial excavations and in subsequent student work, there was investigation of what would now be called site geoarchaeology, but this work was not reported in detail. In this thesis, I synthesize existing records on site stratigraphy and completed new field characterization and laboratory analyses to build a geoarchaeological summary for the site. The site stratigraphy is characterized by episodic deposition and is the result of the interaction of fluvial, aeolian and colluvial processes. Periods of landform stability are marked by soil formation. Sediments preserved on-site appear to contain a relatively complete record of the Holocene, whereas across the creek at 45KT726, the earlier Holocene sediments have been stripped away by fluvial processes. Periods of landform stability and soil formation at Sanders roughly match the alluvial cycles presented for the Fogoil Project on the Yakima Training Center.

ACKNOWLEDGEMENTS

This is the bit where I make the Oscar's acceptance speech and thank everyone who has made a difference in my life: from God, to my pet's psychologist, and the pharmaceutical companies that get me through the day. Therefore, I should like to start with my parents and the spark of life ignited during a night of passion. They have supported my every endeavor since – almost without question - and I generally take them for granted. Thanks Jim and Louise.

This thesis would not have been possible without the hard work of the 1971-72 archaeological field school students and Dr. William C. Smith. Along with Dr. Smith, two students, Peter Bergan and Bruce Cochran, were responsible for the description and illustration of the stratigraphy at Sanders, which is the nucleus my research. Work by Bruce Cochran in 1978 at the site as part of his Master's Thesis was also helpful.

Over the years since the excavation at the Sanders site, many CWU students have helped to analyze parts of the collection. Their collective contributions provided much of the information scattered throughout this thesis. I am grateful.

My committee, Drs. Steven Hackenberger, Patrick Lubinski, and William C. Smith deserve a special thanks for making this thesis a reality. I am very appreciative of Dr. Smith, who has always made himself available to answer questions about the Sanders excavation or anything else I wanted to ask. Thankyou. Dr. Hackenberger introduced me and the Sanders collection and suggested I might look at the stratigraphy as a thesis topic. Many years later Steve is still my champion. His encouragement and optimism has never wavered. Dr. Lubinski helped me realistically define the thesis. He did the hard work of making this a coherent document. Any shortcomings are my own.

I would like to thank Randy Korgel, the base archaeologist at the Yakima Training Center for arranging access for class field trips to the Sanders site. During a follow up visit to the site I was accompanied by Ryan Swanson, then an YTC archaeologist, who spent the day helping me. My fellow students and Dr. Lubinski put in some back breaking work to help expose the profile I described for this thesis. Thanks for the hard work.

Finally, I would like to thank my support team: friends and family. They listen to my complaints and offer solutions and encouragement. My girlfriend, Maryam, has been especially supportive. Thanks to all.

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CHAPTER I

INTRODUCTION

"…every archaeological problem starts as a problem in geo-archaeology."

[Renfrew 1976:.2].

Renfrew's statement underlines the importance of the context provided by the application of geoscience principles and practices to archaeology, which form the basis of geoarchaeology (Waters 1992). Fundamental aspects of geoarchaeology include stratigraphy, site formation processes, and landscape reconstruction (Waters 1992). Understanding the contextual relationship between site sediments and associated cultural material enhances our interpretation of the past.

Applying geoarchaeological principles to material from older excavations can provide much needed context within which to interpret earlier works and synthesize future analysis of archaeological collections. Traditionally, university field schools have been, and remain, important for passing knowledge and skills from one generation of archeologist to the next. The consequence of any such endeavor is the production of large amounts of data and collected cultural material. Transcription and analysis of the collection falters when student tuition money dries up at the completion of the field season and the findings go unreported. This problem, or gap in the process, has often been filled by graduate research programs. Lohse and Anderson (2001), though focused on archival issues, do highlight a common problem, namely, that there are numerous old collections from excavations in university store houses that have not been transcribed and archived.

These are sites like Sanders which can contribute significant information to our knowledge of regional archaeology. The Sanders collection was generated from two field seasons and contains documents such as field notes and sketches, photographs without captions, profiles drawings, as well as the artifacts and samples. Geoarchaeology can provide context for Sanders, and similar collections, aiding synthesis with future analysis and informing subsequent interpretations.

Excavations at the Sanders site (45KT315) were untaken in the summers of 1971 and 1972 under the direction of Dr. William Smith at Central Washington State College (CWSC), an institution renamed Central Washington University (CWU) later in the 1970s (see Figures 1.01-1.02). Work on the Sanders site and analysis of recovered material was postponed to begin the Mesa Project in 1973 (for the latter, see Smith 1977). A comprehensive report on the Sanders site was never completed due to time commitments on future projects and the lack of a graduate program that would provide students to work with the existing collections (William Smith, personal communication, July, 2017).

The Sanders site collection is currently stored by the Department of Anthropology and Museum Studies at CWU, where it is in various states of curation. Undergraduate and graduate research projects subsequent to the 1971-1972 excavations studying particular aspects of the collection have been ongoing since the late 1990s. Projects have focused on lithic tools and debitage, faunal remains, and radiocarbon dating (see Hackenberger and Vantine 2010).

Figure 1.01. Sign for 1972 excavation site ("field station") at the Sanders site. Img124.

The information compiled by the student projects has been tied to the vertical control of the excavation provided by arbitrary 10 cm levels and general stratigraphic layers. Dr. Smith and his students profiled the trench walls of the excavation and included general notes on the exposed stratigraphy. However a more detailed understanding of the stratigraphy is needed if past and future research projects involving the collection are to be integrated into the larger picture of site formation and regional history. The goals of the current research project are to integrate the information provided by Dr. Smith's profiles with student project data in order to provide context for the human occupation of the site and interpret the formation processes of the archaeological record.

Figure 1.02. Overview of 1972 excavations. 1502 is trench on left and "block" on right is trench 1504. View is to the south/southwest. Johnson Creek is just beyond excavation and indicated by strip of green vegetation. Img156.

The overall goal of this thesis is to give geoarchaeological context to the Sanders collection and as a guide to any future work at the site. Accomplishing this goal lies in the completion of 4 objectives.

1) Reconstruct landform history (compile information on stratigraphy and group by depositional environment, soil formation and geochronology)

2) Identify site formation processes (erosion, deposition, soil formation, cultural material, and stratigraphy)
3) Correlate Sanders and 45KT726 geoarchaeology (45KT726 occupies the south bank of Johnson Creek)
4) Discuss if and how the cultural occupation of Sanders relates to Yakima training Center (YTC) alluvial cycles

Organization of Thesis

In Chapter II, I review pertinent literature on the study area and geoarchaeology. Chapter III describes the methods employed in the thesis. Chapter IV explains the previous investigations that occurred on site. In Chapter V, I synthesize the geoarchaeology of the Sanders site. In Chapter VI, I discuss my interpretation of the site and broader implications.

CHAPTER II

STUDY AREA AND PREVIOUS RESEARCH

The Sanders Site (45 KT 315) lies near the center of Washington State in southeastern Kittitas County just east of the Columbia River. This portion of the state is dominated by the Yakima Training Center (YTC), which occupies the southeastern corner of Kittitas County and the northeastern corner of Yakima County (Figure 2.01). The boundaries of the YTC were expanded northward in the 1990s taking possession of federal, state and private landholdings (Sullivan 1994), including the Sanders Ranch where the site is located. The YTC currently is bordered by I-90 to the north, I-82 to the west, WA 24 to the south, and the Columbia River along its eastern flank.

The YTC is located within the Columbia Basin physiographic province. The Columbia Basin Physiographic Province covers much of central Washington and is mostly underlain by Miocene flood basalts (Franklin and Dyrness 1973). These basalts are lavas of the Columbia River Basalt Group (CRBG), which were periodically extruded from fissures in eastern Washington, western Idaho, and eastern Oregon between 16.7 Ma and 5.5 Ma (Reidel et al. 2013). Sedimentary rocks of the Ellensburg Formation are interbedded with and overly the CRBG throughout much of the Columbia Plateau (Reidel et al 2013). Regional uplift, folding, and faulting concurrent with the basalt flows formed the northwest/southeast trending anticlinal ridges and synclinal valleys of the Yakima Fold Belt sub-province (Campbell 1998; Reidel 1984), including the Saddle Mountains, Umtanum Ridge, and Yakima Ridge on the YTC. The north/south trending Hog Ranch-

Naneum Ridge anticline was created concurrently, modifying the fold belt and restricting the westward flow of the Columbia River, confining its course to its present position through central Washington between Wenatchee and Priest Rapids (Reidel et al 2013).

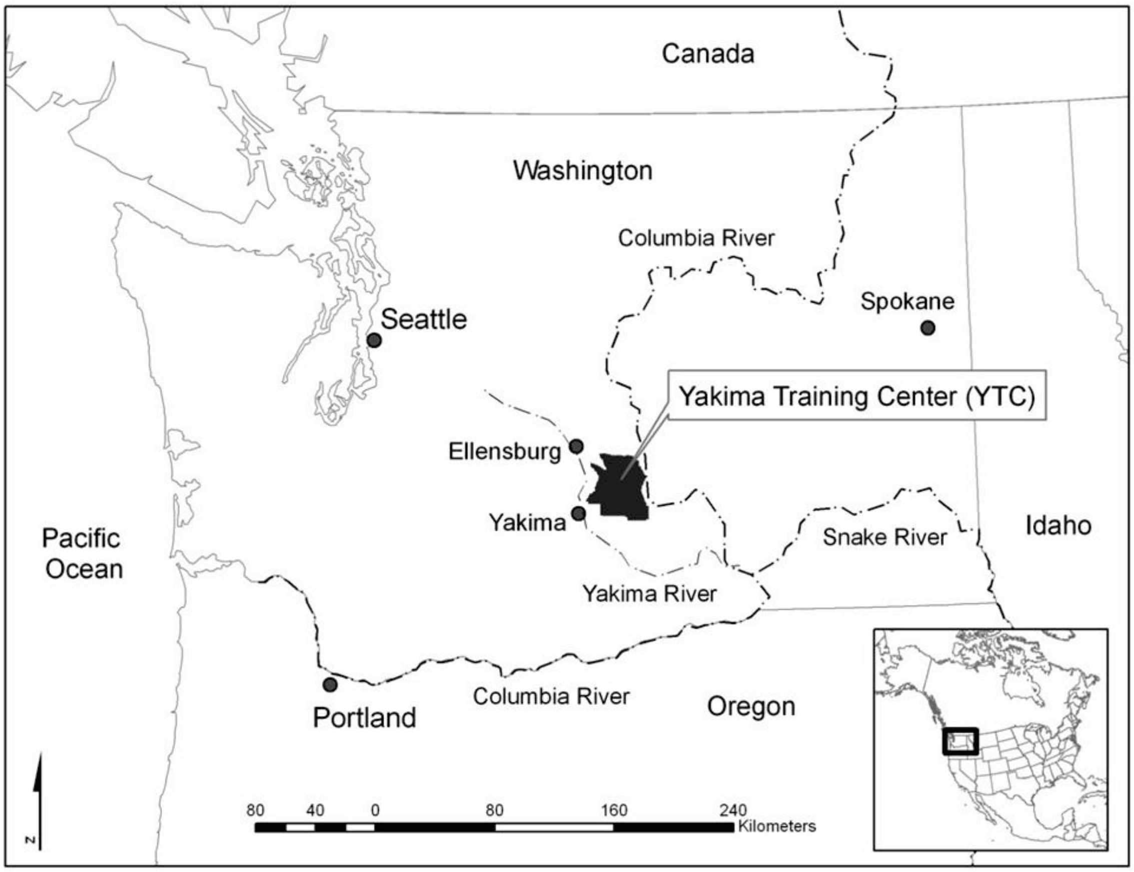


Figure 2.01 Location of the Yakima Training Center (Durkee 2012:Figure 2). The Sanders site is in the northeast portion of the Center.

Plio-Pleistocene loess blankets the area within the borders of the YTC in discontinuous sheets and lenses, comprising much of the valley sediments. Sources of these aeolian sediments include mountain glaciers, tephras, and glacial outburst flood slackwater deposits in the Yakima Valley (Campbell 1998). Glacial impoundment of the

Clark Fork River during the Pleistocene created Lake Missoula in eastern Montana. Repeated failure of the ice dam released huge volumes of water, spilling the banks of the Columbia River resulting in overland flow. The many cross country channel and scoured tracts in the Columbia Basin created a unique topography known as the channel scabland (Baker and Bunker 1985). Deposits associated with these floods include channel and ponded sediments. On the west side of the YTC bordering the Columbia River, the many mouths of tributary streams, including Johnson Creek, contain ice rafted and slackwater sediments from the Missoula Floods (Cochran 1978).

The Sanders site lies adjacent to Johnson Creek, in the northeastern portion of the YTC. The Johnson Creek watershed drains approximately 31 square miles and is defined by the Hog Ranch-Naneum Ridge anticline to the east, the Saddle Mountain anticline to the south, and an unnamed ridge in the north (Sullivan 1994). Creek headwaters are on Boylston Mountain at 2600 ft. and flow 12 miles east to join the Columbia River at Getty's Cove with an elevation of about 600 ft (Sullivan 1994). Base water flow comes from springs and seeps and is augmented by rainfall runoff and snowmelt. The creek is intermittent along its course, particularly in the lower reaches where flow infiltrates highly permeable Missoula Flood clastic sediments.

The Sanders site is approximately 7.5 km upstream of the Columbia River, on the north bank of the creek (Figure 2.02). The site elevation is approximately 350 m above mean sea level which is near the high water mark of ponded Missoula Flood sediments determined by Cochran (1978). However, the observed lithology along this stretch of the creek, and in the site sediments, indicate a local basalt bedrock origin rather than flood sediments (Gough 1999).

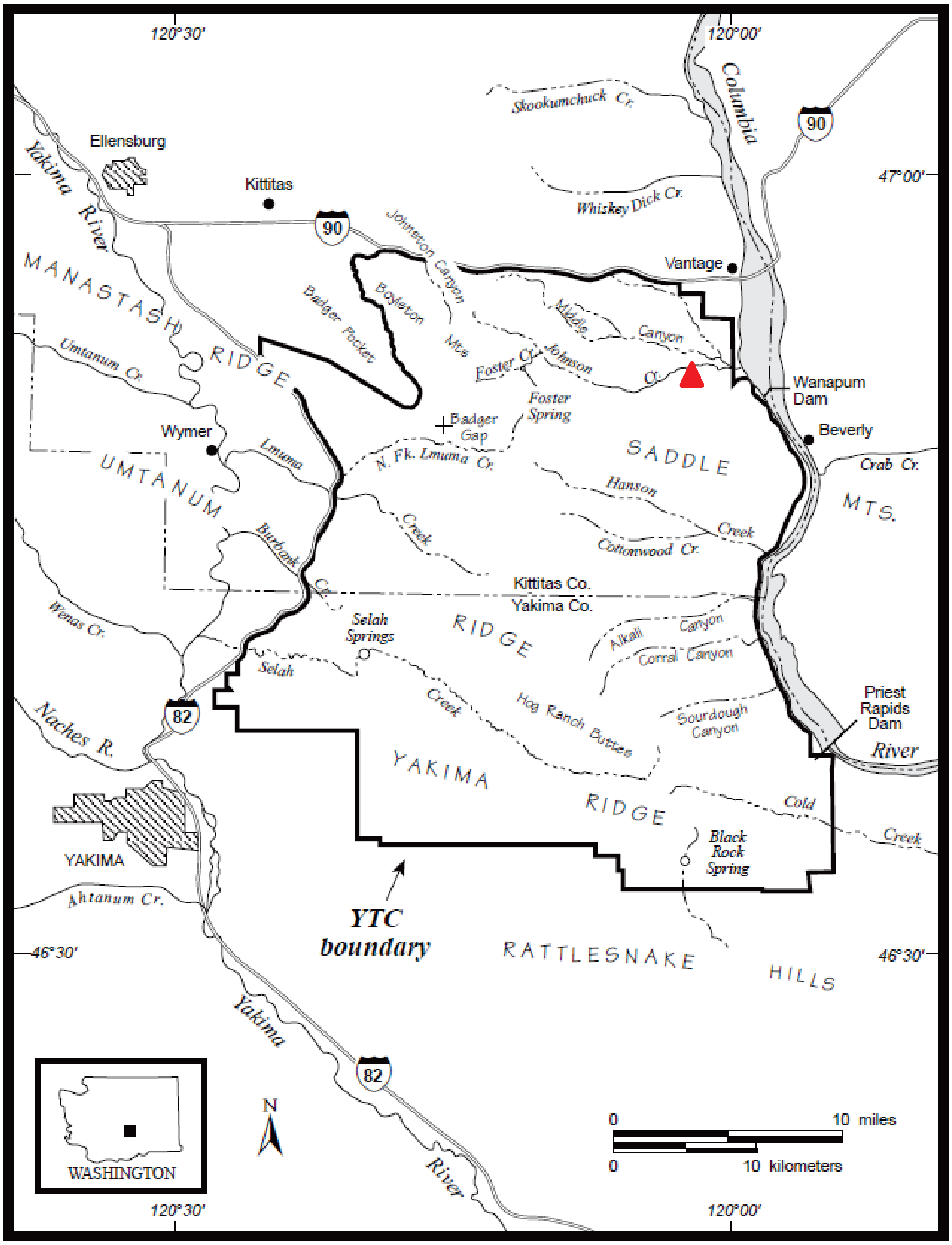


Figure 2.02 Location of the Sanders Site within the YTC. Site is indicated with red dot. Modified from Galm et al. (2000:Figure 1.2).

At the Sanders locality, Johnson Creek is confined to a narrow, incised channel which flows along the northern central part of the valley. The valley floor slopes gently south and downstream to the east leaving the northern valley up to two meters higher in elevation than its southern counterpart. Alluvial fans enter the narrow valley from the south both above and just below the position of the Sanders site on the creek. All of these features are set within rolling topography, so that to the west of the excavations there is a steep slope (see Figure 2.03).

Figure 2.03 Photograph of the Sanders Site locale. Site is located where the people are standing, indicated by a red arrow. Photograph by the author in April 2012.

Previous Research in Johnson Canyon

Archaeological and geomorphological work on the YTC has generally been oriented toward resource management or federal compliance for the preservation of cultural resources. Other projects are academic endeavors undertaken as part of student research (undergraduate, Master's thesis, and Ph.D. dissertation), most often affiliated with CWU. These archaeological projects tend to be broad in scope and synthetic in nature. The 1971-72 work at the Sanders site on Johnson Creek, though not on YTC property at the time, is the only excavation undertaken for purely research purposes within the current YTC. Following is a brief review of three projects which have direct bearing on this thesis.

Cochran completed a Masters of Science thesis at Washington State University in 1978, investigating the late Quaternary stratigraphy in Johnson Canyon. The study documents the stratigraphy at a number of locations along Johnson Creek, including the Sanders site. An alluvial chronology was constructed based on radiometric dating of periods of stream aggradation and erosion. This sequence was then compared to regional alluvial chronologies established for central Washington, concluding that regional forces are controlling stream processes. Cochran also compared alluvial sequences to alpine glacier fluctuations, an inferred temperature curve, and rock fall in caves to deduce that climate was the major force in controlling stream regimens in central Washington.

Cochran's alluvial chronology for Johnson Creek is as follows: Beginning at the Pleistocene-Holocene boundary, short periods of stream down cutting or erosion are followed by longer periods of deposition or aggradation. Soil development accompanies spans of time when the stream banks are stable. The first identified period of erosion ended before 8,400 B.P. and was followed by aggradation. Down cutting began again sometime before 6,800 B.P. and was succeeded by aggradation which included the Mazama ash fall. Erosion beginning before 5,500 B.P. was followed by roughly 2,500 years of aggradation. The stream incised again before 1,700 B.P., aggrading thereafter until modern degradation began about 200 years ago.

Cochran's (1978) work is particularly important for my study for two reasons. First, he documented two profiles at the Sanders site and composed a composite sketch of Johnson creek at that locale. Second, he defined sedimentary layers and presents a model for alluvial cycles.

Site 45KT726 lies south directly across Johnson Creek from the Sanders site Figure 2.04), and has been investigated twice by Archaeological and Historical Services (AHS) of Eastern Washington University (Gough 1999; Gough and Ives 2002). Both the initial testing (Gough 1999) and the later, more intensive investigation involving backhoe trenching (Gough and Ives 2002) provided some geoarchaeological data comparable to the Sanders site. The profile drawings and dated stratigraphy presented are particularly important for interpreting the geomorphology of the Sanders locality.

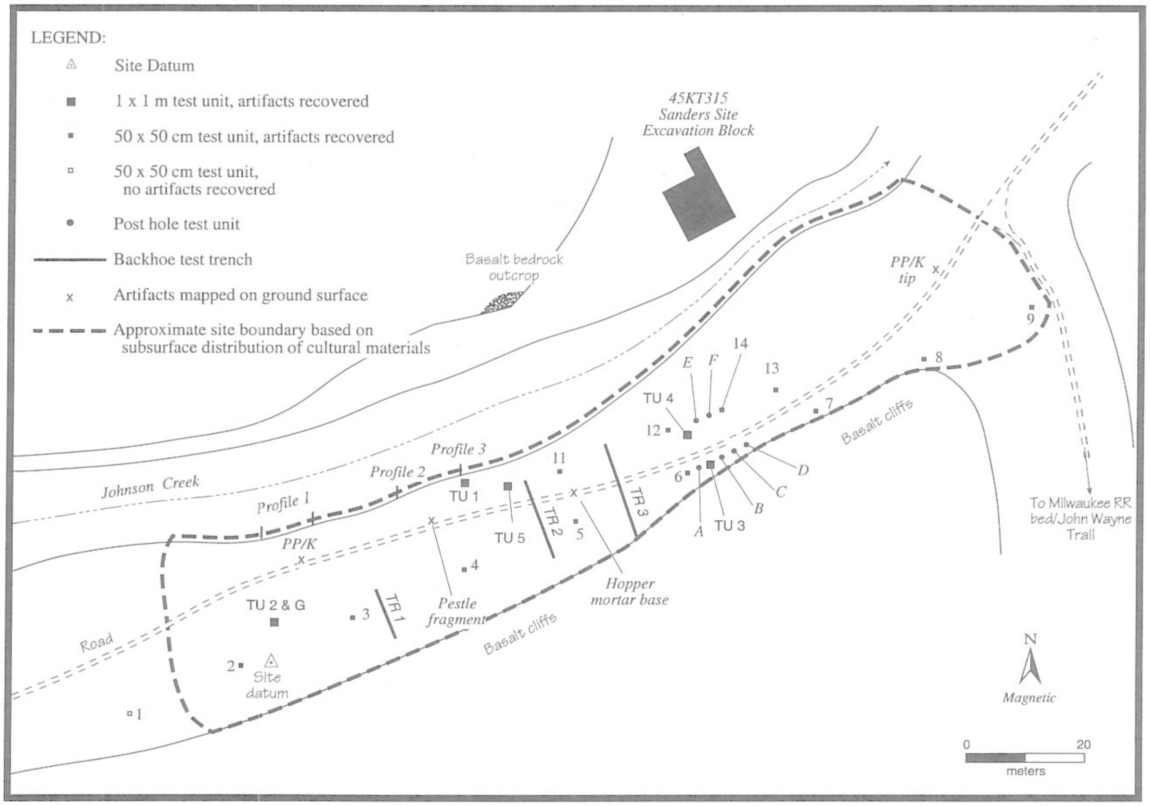


Figure 2.04. Map of AHS investigations at site 45KT726 in relation to the Sanders site (Gough and Ives 2002:Figure 2).

Another pertinent AHS project on the YTC is the Fogoil Alluvial Chronology project reported by Galm et al. (2000). The impetus for this study was a proposed new Army training method for creating artificial fog that could introduce fine particulate carbon onto the Training Center. This was thought to potentially contaminate future radiocarbon dating, so the Fogoil study set out to establish a reference suite of radiocarbon dates for future comparison. The project was generally focused on alluvial sequences in the major drainage basins, with particular emphasis placed on buried organic soils and tephra layers in exposed profiles. The potential and relative age range for buried archaeological material along the major stream channels was also assessed.

CHAPTER III

METHODS

Information on 1971-72 Fieldwork

Investigation of the Sanders excavation was aided by a number of sources which were used to summarize the nature of the 1971-72 fieldwork. Paramount among those sources has been communication with Dr. Bill Smith. He has graciously shared his time and answered rounds of questions from Dr. Hackenberger, other students, and me. Documentation of the 1971 and 1972 field seasons includes field notes, level forms, drawings, and photographs. Listed below (Table 3.01) are the documents available from the original fieldwork. A short summary of the investigation is reported in the Fall 1972 *American Antiquity* Current Research section (King 1972:567). Additional information on the broad goals, methods, and termination of the Sanders site investigations was understood from two field reports for other projects that pre- and post-date the Sanders site excavation. *Descriptive Archaeology of the Umtanum Creek Site* (45-KT-101) by Smith (1971) provides a descriptive summary of the 1969 field season and subsequent analysis of that site. Work on the Sanders site and analysis of recovered material was postponed to begin the Mesa Project in 1973. The Mesa Project is reported by Smith (1977).

Table 3.01. Available Original Documentation of the Sander Site 45KT315

Document Type	Year(s) available
Field survey/ site reconnaissance form	1970-71
Pit/ level record	1971
Photographs – mainly black/white prints or contact sheets but some color slides	1971-72
Profile drawings	1971-72
Artifact tally forms	1971-72
Field notebook	1972
Artifact illustration cards	1972
Campus Cryer newspaper article (CWSC)	1972
Advertisement for summer field school	1970

During the first season at Sanders, standardized pit/ level records were used to record observations made while excavating and a plan view map was drawn illustrating the 'floor' or base of each level. This information was recorded in a field notebook during the 1972 field season. Artifact tally forms accompany excavation records during both seasons and document the weight and count of each artifact class per level. Artifact classes or categories include lithic, bone, shell, wood, and other (metal, glass, ceramic). Selected artifacts were illustrated on individual notecards in the field lab set up at the Sanders Ranch house. Photographs document archaeological features, trench stratigraphy, excavation and screening methods, area overview, and the daily progression of the fieldwork.

An attempt was made to retrieve a roster of students enrolled in the "Workshop in Archaeology" courses for summer 1971 and 1972 fieldwork at Sanders. It was assumed that the 1971 and 1972 courses were like the 1970 summer field school flyer, which noted that:

"Students will register for 12 units, to be selected from the following list:

Anth 360.1 Archaeological method and theory (4)

Anth 360.2 Laboratory methods in archaeology (4)

Anth 360.3 Field methods in archaeology (4)

Anth 460 Advanced methods in archaeology (4)" [Department of Anthropology 1970]

However, the CWU Registrar's Office would not release that information, citing the federal Family Educational Rights and Privacy Act (FERPA). Therefore a list of student participants is not provided.

The summary of fieldwork which follows in Chapter IV was created using the unpublished documents and photographs listed in Table 3.01. Since these constitute a mix of diverse unpublished sources, I will not provide reference citations below. It should be noted from Table 3.01 that some documents are not available for both field seasons. Of particular importance for this thesis are the missing pit/level records for 1972 and the 1971 field notebook.

Procedures for 2012 Field Stratigraphic Characterization

For this thesis, I completed a field investigation and a laboratory investigation of sediments at the Sanders site. The field investigation was undertaken in Spring Quarter 2012 for an individual research project in partial fulfillment of course requirements for Anth 527 Environmental Archaeology, taught by Dr. Pat Lubinski.

My investigation, in April and May of 2012, involved facing off and describing the west wall of Trench 1504. At that point, it was clear that the Sanders excavations had remained open since the 1971-72 field seasons. Excavated sediment for back filling was not available due mainly to water screening and transport downstream. The vertical walls of the excavation had since been subjected to continual weathering resulting in retreat of the upper trench walls. Sheet flow, trench wall slump, and re-worked sand transported by down valley wind has back filled portions of the trenches.

For the course project, a small section of the west wall of Trench 1504 near the creek was selected for description and analysis. This particular wall of the excavation was chosen for a number of reasons. The depth of the excavation along the southern walls next to Johnson Creek was among the deepest. Due to natural formation processes subsequent to excavation, the west wall was more protected, less exposed than the eastern wall of Trench 1504 or Trench 1502. Also, the presence of an old fence post, identifiable in the original excavation photographs (Figures 3.01-3.03), made an approximation of the southwest corner of Trench 1504 more certain.

Preparing, or facing, the trench wall for profiling and description was accomplished over two visits to the site. The first was part of a field trip for a geoarchaeology course on April 28, 2012. During the excursion, the wall of Trench 1504 to be profiled was exposed with the help of fellow class members and Dr. Lubinski. A few weeks later I was accompanied by Yakima Training Center archaeologist Ryan Swanson, and was able to face, photograph, and describe the profile.

Figure 3.01. Excavation in Trench 1504 showing West Wall, in 1972. Note fence post in top left indicated by red arrow. File Img86.

Figure 3.02. Overview of excavations in mid-1972, view to south. Note fence post in top left indicated by red arrow. File Img51.

Figure. 3.03 Exposure of Trench 1504 west wall in April 2012. Note the fence post indicated with the red arrow.

Approximately two vertical meters of the west wall of Trench 1504 was profiled and described. The width of the profile was restricted to 50 cm due to the time it takes to face and to lessen the impact of vertical exposure. The profile had to be stepped since it was no longer vertical due to slumping of the upper portion. Approximately the upper 75cm of the profile was too loose to face and was therefore not formally described. The modern surface likely differed from that of the 1971-72 excavations due to eolian re-working. A line level was used for vertical control during profiling. However, I was unable to tie the profile level into the 1971-1972 site datum. Vertical control was, therefore, relative to the present surface. Horizontal control was also relative and established based on approximating the footprint of Trench 1504. Using the fence post in Figures 3.01 and Figure 3.02 as a guide, the measured section I profiled corresponds to the northern half of Unit 13. The degree of slope retreat can be seen in a photograph of the Sanders project during the 1972 excavation which shows that the wooden fence post was about 2 meters distant from the west wall of Trench 1504 (Figure 3.02). In 2012, the fence post can be seen just above the excavators head (Figure 3.03). The trench wall had retreated nearly to the base of the post.

Sediment characteristics were described using standard definitions (Birkeland 1999; Schoeneberger et al 2012; Waters 1992) and included color, texture, particle sorting, large particle description, particle fabric, sedimentary bedding, inclusions, soil structure, ped consistence, effervescence, carbonate stage, and boundary morphology. Matrix and clast particle size was determined in the field by hand texturing for the finer fractions (Thien 1979) and visual inspection for gravels. Based on these characteristics, the sediments were subdivided into 8 stratigraphic layers. Bulk sediment samples were collected from the middle of each of the layers for particle size analysis. These samples were excavated out of the profile wall to fill a plastic zip-top bag about 3 x 5" in size. The profile was backfilled to mitigate further erosion.

Procedures for 2012 Particle Size Analysis

The laboratory investigation was undertaken in Spring Quarter 2012 for an individual research project in partial fulfillment of course requirements for Geol 570

Fluvial Geomorphology, taught by Dr. Lisa Ely. The project involved particle size analysis of sediment samples collected for the Anth 527 course in April 2012 (see above).

In the lab, a sub-sample of the eight identified stratigraphic layers from my profile of the west wall of Trench 1504 were prepared for analysis by air drying, but no weighing or pre-treatment for removal of carbonates, organic carbon, etc., nor deflocculation was performed. The sample was very fine grained, so it was appropriate for particle size analysis with a Malvern Mastersizer 2000 without sieving out course sediments first.

Analyses of the eight samples was made using the Malvern Mastersizer, a laser diffractometer, following the methods described by Sperazza et al. (2002) and the user manual (Malvern Instruments 2007). Small amounts of the fine fraction – clay, silt, fine sand – of the sampled matrix were fed into a small chamber with circulating water. The spinning of the water and matrix saturates and suspends the fine particles. The sediment-laden water is then piped through a tube and passed between two glass plates in front of the laser. The sample is circulated three times while the laser fires and calculates the particle size ratio. Estimates are based on Mie theory which deals with diffracted light (Sperazza et al. 2004). The data is graphed according to particle size per volume percentage and presented in micrometers.

Procedures for Synthesizing a Comprehensive Site Stratigraphy

Integrating my work with previous documentation of the stratigraphy at Sanders relied on several sources. Foremost among the records are the measured profile sections illustrated by Dr. Smith and his field foreman, Peter Berghan and fellow student Bruce Cochran (listed in Table 3.02). The majority of the profiles were drawn as a collaborative effort with much debate over the description and sub-division (Dr. Smith, personal communication, 2017). Unfortunately, notes on stratigraphy are lost, leaving the profile maps as the main source of information. Photographs and field notes were also helpful with reconstructing the stratigraphy.

Table 3.02. Original profile drawings from the 1971-72 field seasons.

Trench/ Unit	Profile	Length of Profile (m)	Units Included
1502	East Wall	14	16,8,22,6,20,18,14,4,12,29,26,28,30
1502	West Wall	17	9,15,7,21,5,19,17,13,3,11,1,23,25,27,29,31,33
1503	All 4 Walls	2	01
1504	North Wall	6	23,24,25,26,27,37
1504	South Wall	6	43,8,9,10,11,12
1504	West Wall	7	12,13,15,17,19,21,23

Prior to my research, the original profile drawings were scanned and formatted as JPEG images and printed. I traced the printed copies to create clean copies of the original profiles drawings. These were used to develop a synthesis of stratigraphy for the thesis. Formal profile photographs, a standard procedure today, were not part of the process in the early 1970s when the site was excavated. However, there are a number of photographs of the crew and excavation which clearly show trench walls, as in Figure 4.11 for example.

My interpretation of the Sanders stratigraphy was described based on the 1971-72 profile drawings, field notes, and photographs, Cochran's (1978) Masters of Science thesis, reports for the projects across the creek (Galm et al. 2000; Gough 1999; Gough and Ives 2002), and my 2012 course projects. My documentation includes particle size distribution, soil development, and pedoturbation. Matrix and clast particle size was determined in the field and refined based on the particle size data from my 2012 Fluvial Geomorphology project. Sediments were classified according to the Udden-Wentworth grain size scale (Birkeland 1984; Prothero and Schwab 2003) for laser diffractometer particle size data and hand texturing. Soil horizons and characteristics were defined according to Natural Resources Conservation Service (NRCS) criteria and standards (Schoeneberger et al 2012; Soil Division Staff 2017).

CHAPTER IV

PRIOR WORK AT 45KT315

1971-72 Field School Excavation Methods

Archaeological reconnaissance of the Sanders Ranch property had been initiated the previous summer, 1970, and continued through the spring of 1971. One goal of the survey was to locate a suitable site for investigation of upland resource use, site function, and settlement pattern. Of the sites identified along Johnson Creek, the Sanders site was selected for testing based on initial observations. The potential of buried archaeological remains was recognized at the site in part because of looting by local relict hunters. Lithic artifacts and freshwater shell was present in the back dirt of the looters' excavations. Therefore, investigation of the site had the added benefit of forestalling further destruction from artifact collectors.

In the summer of 1971, Dr. Smith and a crew of Central Washington State College (CWSC) students began excavation at the Sanders site. At that time, the Sanders Ranch was leased by Phil Kern, who along with the Sanders family, gave permission for the CWSC field school excavations (Smith, personal communication, 2017). Excavations were undertaken in the summer of 1971 and 1972 as "Workshop in Archaeology" courses with approximately 15 students each summer.

Two local datums were set to facilitate mapping and maintain vertical control (see Figure 4.02). Both are visible in a 1972 field photograph (Figure 4.03), with a dumpy level and tripod set up over the south datum. The north datum was placed several meters north of the anticipated excavation area. On Figure 4.02, it is located 1 m east and 4 m north of the northeast corner of Trench 1502. A second datum, located 1m east of the northeast corner of Trench 1502, was placed near the excavations and used for vertical control, according to the 1972 field notes by Dr. Smith.

Figure 4.01. Trench 1502 (left) and Trench 1501 (right) during 1971 field season. View is southeast.

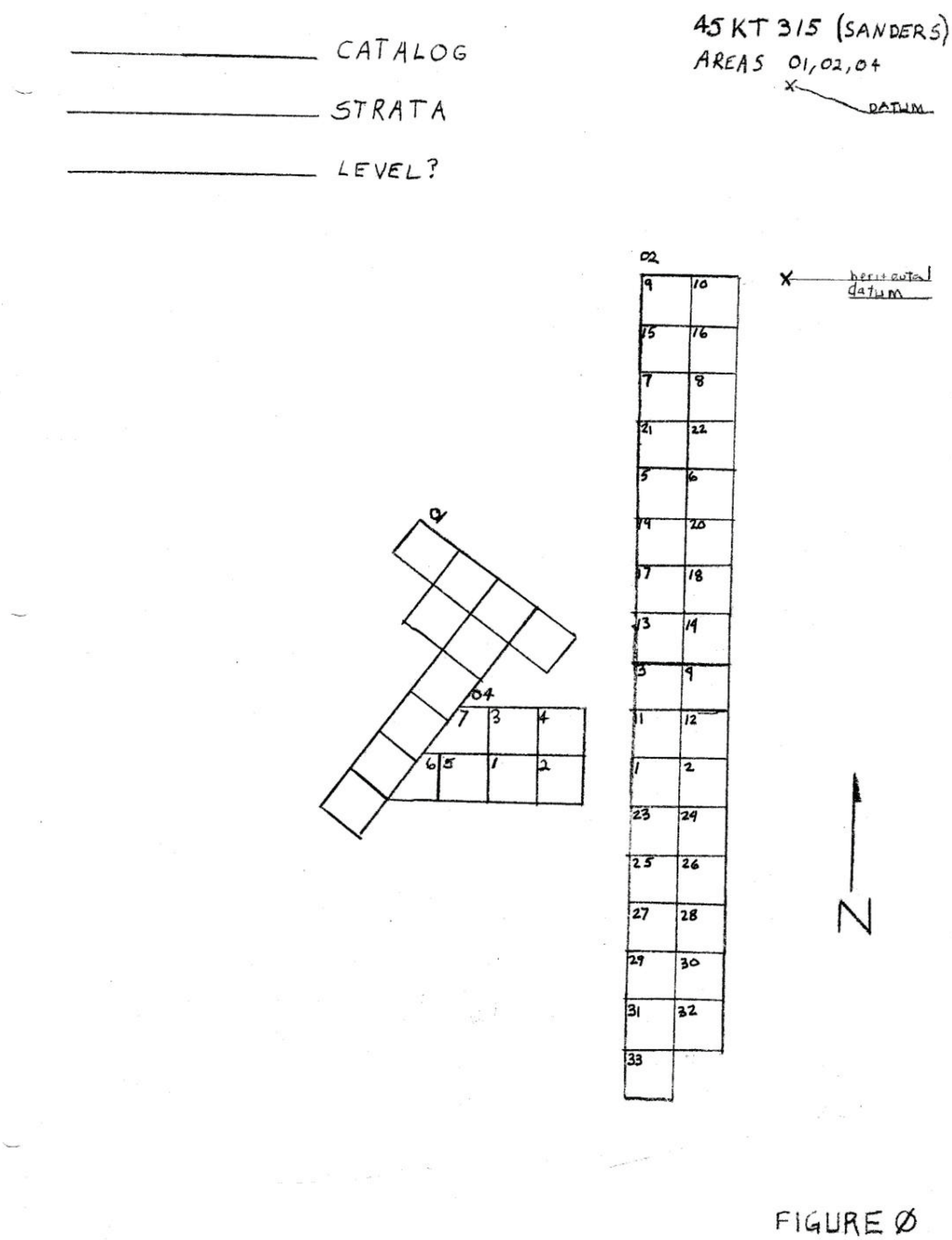


Figure 4.02. Excavation map at the conclusion of the 1971 season. Modified from scan of original 1972 field notebook. The 1502 trench is the N-S trench to the east, with 33 individual units. The angled trench is 1501, while the 1504 trench is west-east with seven individual units. The X labeled “horizontal” is the mislabeled vertical datum, while there is no record of a datum at the location of the X above it.

Figure 4.03. Trench 1502 (left) and Trench 1504 (right) being overlaid on Trench 1501 (angled southwest) early in 1972 field season. View in to the south, southwest.

According to Dr. Smith, before fieldwork began, Dr. Jim Alexander (another CWSC Anthropology professor) set up the excavation unit locations with an optical transit. Units were mapped in horizontal view with a plane table and alidade, and vertical control was maintained by use of a vertical datum, a dumpy level, and a hand-made graduated rod. Figure 4.04 shows the use of a dumpy level and also has the plane table nearby.

Figure 4.04. Taking elevations with a dumpy level in 1972. File Img166.

Units generally have horizontal dimensions of 1 x 1 m and range in depth from just 50 cm to approximately 2.8 meters below the surface. The grid was organized in blocks of contiguous units and labeled as Trenches 1501, 1502, and 1504. Units were numbered consecutively within each trench and were laid out in groups when needed, expanding the trenches incrementally.

Trench orientation was initially based on the physical parameters of the looter pits and give Trench 1501 its northeast to southwest trend. Eleven 1m x 1m units originally made up Trench 1501. Ten of the units were located in a contiguous block in the looted area of the site, while a single 2 x 2 m unit was excavated in an undisturbed area approximately 8 m east. Poor recovery precluded further investigation near the lone unit which was subsequently re-labeled as 1503.The investigation in Trench 1501 quashed initial concerns that looting had destroyed the depth of the deposit. Being that only the upper 10-50 cm (Strat 1A) of the archaeology was adversely affected, plans were made to expand. Contrary to Trench 1501 and Unit 1503, Trenches 1502 and 1504 were set with a north/ south orientation. Trench 1502 measures 17 m by 2 m and is made up of 33 units. Depth of excavation in Trench 1502 is variable and ranges from 50 cm to approximately 2.3 m below the surface. Trench 1504 overlays the footprint of Trench 1501 creating a block that measures 7 by 7 m. Though containing 49 square meters, the numbering of units is not one to one and was modified to accommodate half units created by the remains of Trench 1501. Excavation in Trench 1504 reaches a maximum depth of 2.8 m below the surface. A sketch of the trench configuration in the middle of the 1972 season is provided as Figure 4.05, and a photograph of the final configuration of trenches in 1972 is provided as Figure 4.06.

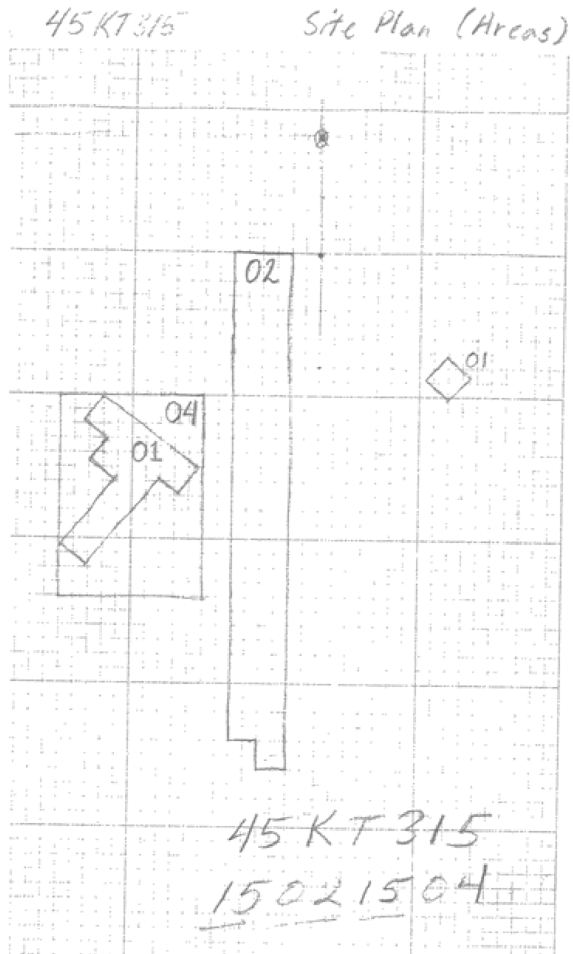


Figure 4.05. Sketch map of trench configuration, from mid-season, out of the 1972 field notebook.

In general, designated 1 x 1 m units were individually excavated, the exception being the early stages of Trench 1504 excavation when 4 units were combined into 2 x 2 m blocks to facilitate the removal of disturbed overburden – Strat 1A. Excavation proceeded in 10 cm increments or levels with a trowel or flat shovel. If the excavated material or matrix was loose, it was dry screened through ¼ inch hardware cloth. If hardened or cemented, the matrix was water screened through ¼ inch mesh in an area of Johnson Creek dammed temporarily for this purpose (see Figures 4.07 and 4.08).

Figure 4.06. Overview of excavations in mid-1972, view to south. Note north-south trench on left (1502) and east-west trench on right (1504). File Img51.

Features encountered during excavation were carefully exposed, drawn, and photographed. The feature matrix was separated from that of the unit levels and water screened with recovered material labeled with its unique provenience. Figure 4.09 provides an example of an exposed feature.


Figure 4.07. Water screening in 1972. File Img94.


Figure 4.08. Processing screened matrix in 1972. File Img65.

Trench wall profiles were scraped or "cleaned" and photographed before being illustrated on large sheets of butcher paper (see Figure 4.10) by Dr. Smith or his students.

The identified stratigraphic layers were numbered 1 through 6 from the surface down. Sediments were described based on color, texture, particle sorting and fabric, and contents (e.g., artifacts, charcoal). Color descriptions were made using a Munsell Soil Color book (William Smith, personal communication, 2017). Variation within layers was designated with a lowercase letter following the stratigraphic number, for example Layer 3b. Bulk sediment samples were collected from representative stratigraphic layers.

Figure 4.09. Example feature from 1972. This is Feature 3 from Pit 25 Level 10, 100 cmbd, Statum 3 on July 14, 1972. File Img26.

Excavation at the Sanders site was discontinued due to the urgency of the Mesa Project which started the following year, 1973, and continued through 1975 (see Smith 1977 for summary). Subsequently, a summary report for the field excavations of the Sanders Site was sidelined.

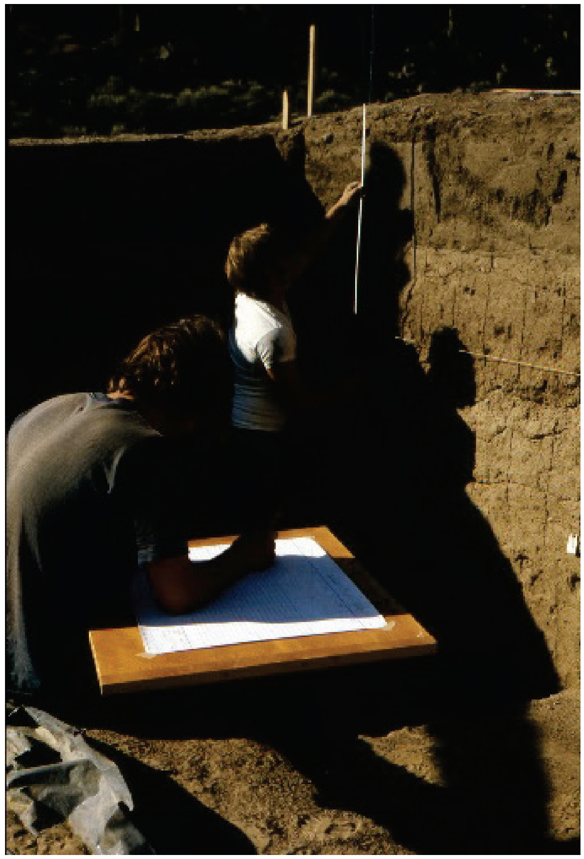


Figure 4.10. Profiling West Wall Trench 1504 in 1972. File Img78.

Later Student Projects and Findings

A number of student projects have been completed on the excavated Sanders site materials since the excavation was terminated. These have included work by undergraduate and graduate students for individual CWU courses and also for graduate student theses and funded research projects such as undergraduate Farrell Scholarship projects. See Hackenberger and Vantine (2010) for more details. Hackenberger has compiled a list of student projects and faculty collaborations to be published on CWU Scholar Works. Following will be a discussion of prior student projects that most closely relate to the geoarchaeology of the site, the topic of this thesis.

In 1971, Greg Cloud investigated the exposed stratigraphy of Johnson Creek Canyon between the Sanders Ranch and the Johnson Creek site or Sanders site (45-KT-315). He produced a short report for Dr. Smith (Cloud 1971). He related his observations to geomorphological processes and speculated about how those effects would influence site occupation.

Bruce Cochran, who worked at the site in the 1972 field season, wrote a Master's thesis about the geology of Johnson Creek at Washington State University in 1978 (Cochran 1978). This investigation included characterizing trench profiles from the 1971-1972 excavations. His work is discussed in more detail in both the literature review (Chapter II) and the site geoarchaeology (Chapter V).

David Woody, a CWU Resource Management graduate student, began field investigations at the site in the late 1990s as part of a proposed Master's thesis. He organized the sediment samples and paper documents from 1971-1972 excavations at the site as part of his proposed thesis. Small samples of the collected sediments were sent to Douglas Frink for oxidizable carbon ratio dating.

Sanders sediments were dated in 1998/99 by Douglas Frink from six samples selected by Dave Woody. The project was directed by Brantley Jackson, the YTC Cultural Resource Manager at the time. The oxidizable carbon ratio (OCR) method of dating employed by Frink (Frink 1994) has subsequently been questioned (Killick et al. 1999) and will not be included in the geochronology presented here. For a discussion of the pilot dating project and Frink's results see Hackenberger and Vantine (2010).

Three undergraduate students conducted studies of faunal remains, Ward and Gray (see Ward 1999) and Vantine (2009). Investigations of shellfish remains contributed to the geoarchaeology of the site by providing radiocarbon dates from bone (Vantine 2009 and Hackenberger and Vantine 2010).

Undergraduate Margaret Ainsley (2010) presented a poster on the geoarchaeology of the site at the Northwest Anthropological Conference in Ellensburg. As part of this project, she obtained three more radiocarbon dates on bone. Ainsley also used dates obtained by Laura Dice funded by the College of the Sciences. Table 4.01 summarizes all of the radiocarbon dates obtained on the site to date. Bone samples were selected and submitted for testing from proveniences pertinent to the particular research goals of each of these student projects. Therefore, the majority of samples submitted and dates obtained are clustered in space and age range.

Table 4.01. Sanders Site Dating Summary

Method	Lab #	Material	Provenience[1]	Stratum	Raw Age, 1 sigma	Reference
AMS		Bone	15002213[2]	II(3 or 4)	2880 ± 70 BP	Hackenberger and Vantine 2010
AMS	Beta-259169	Bone	15021825	IV(upper 6)	2890+/- 40 BP	Hackenberger and Vantine 2010
AMS	Beta-245284	Bone	15020415	I or II (2 or 3)	2950 ± 40 BP	Vantine 2009
AMS	Beta-245283	Bone	15020411	I(1a)	2970 ± 40 BP	Vantine 2009
AMS	Beta-245285	Bone	15021213	I(2)	2980 ± 40 BP	Vantine 2009
AMS		Bone	15041318 S5	III(5)	3550±40BP	Ainsley 2010
AMS		Bone	15041119 S6	III(5)	4930 ±40 BP	Ainsley 2010
AMS		Bone	15022727	IV(upper 6)	8780±40 BP	Ainsley 2010
AMS	Beta-259170	Bone	15022833	V(lower 6)	9340 ± 50 BP	Hackenberger and Vantine 2010

[1]Provenience is listed as a numerical value and breaks down as trench, unit, and level. The second date listed is from Trench 1502, Unit 18, and Level 25.

[2]This provenience does not make sense as listed, because there is no Trench 1500. This is probably a typographic error from earlier summaries of dates.

CHAPTER V

GEOARCHAEOLOGY OF THE SANDERS SITE

This chapter presents the documentation of stratigraphy at Sanders which is available. It includes both original 1971-72 fieldwork data, information from Cochran's (1978) Master's thesis research, and my own 2012 fieldwork and sediment lab analysis. Besides stratigraphic information, it includes a description of sediments in each stratum (including distribution or density of artifacts) and geochronology. These will be discussed in chronological order of investigation.

1971-1972 Fieldwork

Strata identified during the excavation of Sanders were described as 7 discrete layers. The layers were sub-divided based on minor changes in identifying characteristics. Examples of a 1972 profile photograph (Figure 5.01) and a portion of a 1972 profile drawing (Figure 5.02) are provided below.

I redrafted the 1972 profile maps, which were all similar to Figure 5.02 and originally drawn on long sections of butcher paper. In my redrafted profile drawings, I corrected errors, removed doodles and notes, and created clean depictions of the stratigraphic lines without horizontal excavation level lines or notes. The six profiles that correspond to the characterized sections below (Tables 5.01-5.06) are provided as Figures 5.03-5.08.

Figure 5.01 Profile of western portion of south wall of Trench 1504 in 1972. Img129.

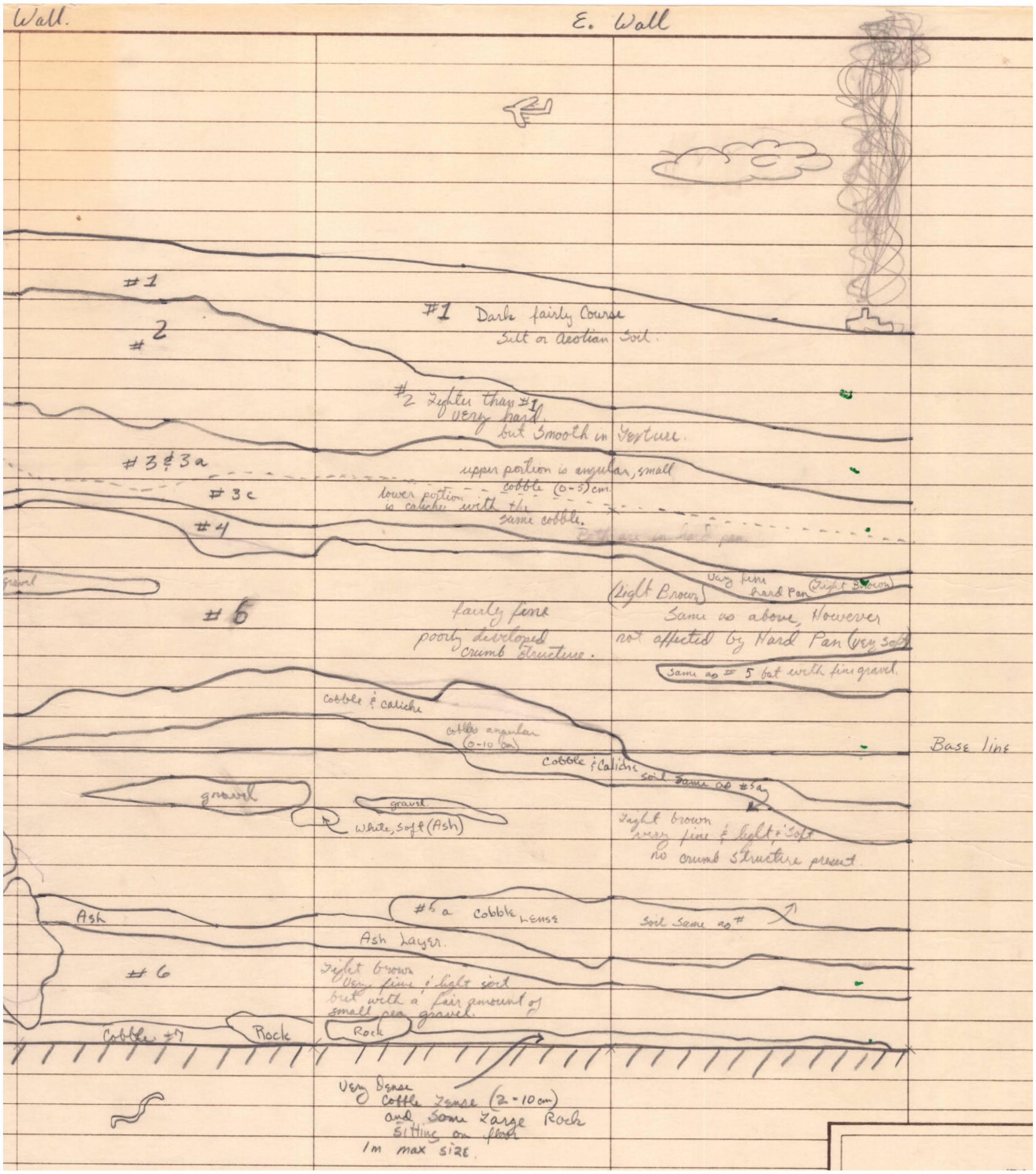


Figure 5.02 Portion of Trench 1503 north and east wall profile drawing from 1972.

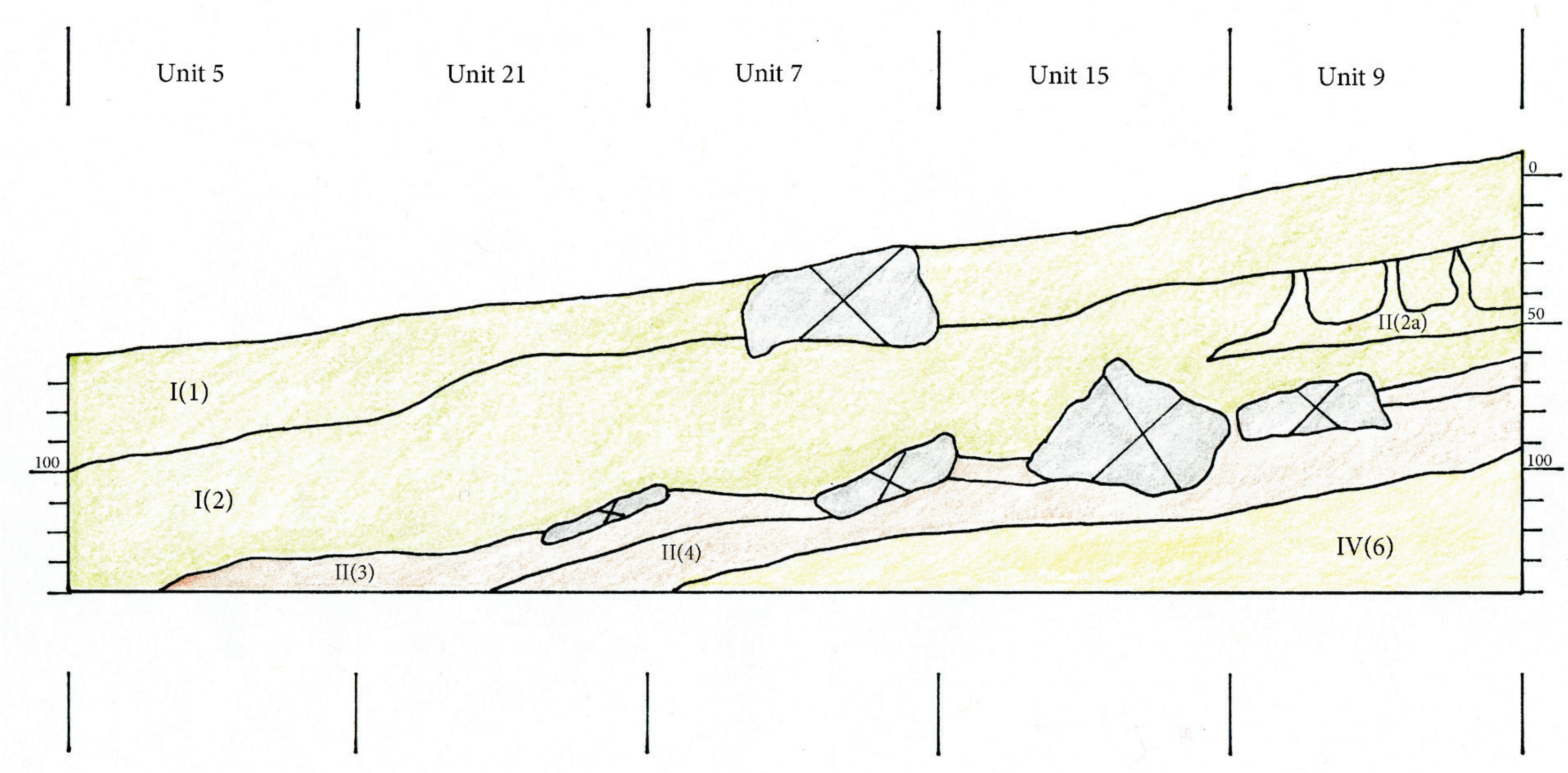


Figure 5.03. Redrafted drawing of the northern portion of the west wall of Trench 1502. Roman numerals correspond with synthesis of stratigraphy described at the end of this chapter, while numbers in parentheses correspond to the original 1971-72 layers. Top line is ground surface, bottom line is base of excavation, and polygons with X's are rocks.

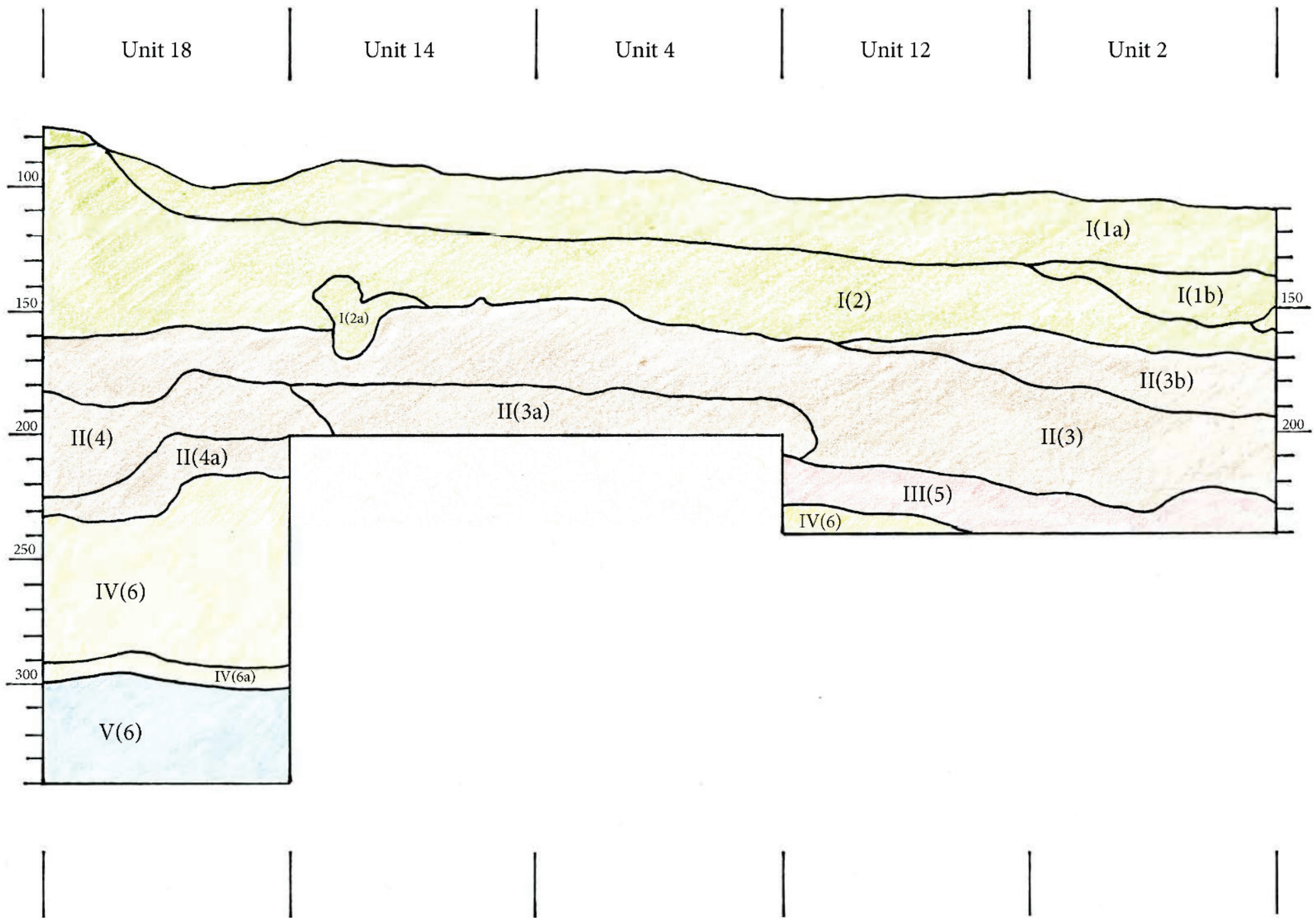


Figure 5.04. Redrafted drawing of the middle portion of the east wall of Trench 1502. Roman numerals correspond with synthesis of stratigraphy described at the end of this chapter, while numbers in parentheses correspond to the original 1971-72 layers. Top line is ground surface, bottom line is base of excavation, and polygons with X's are rocks.

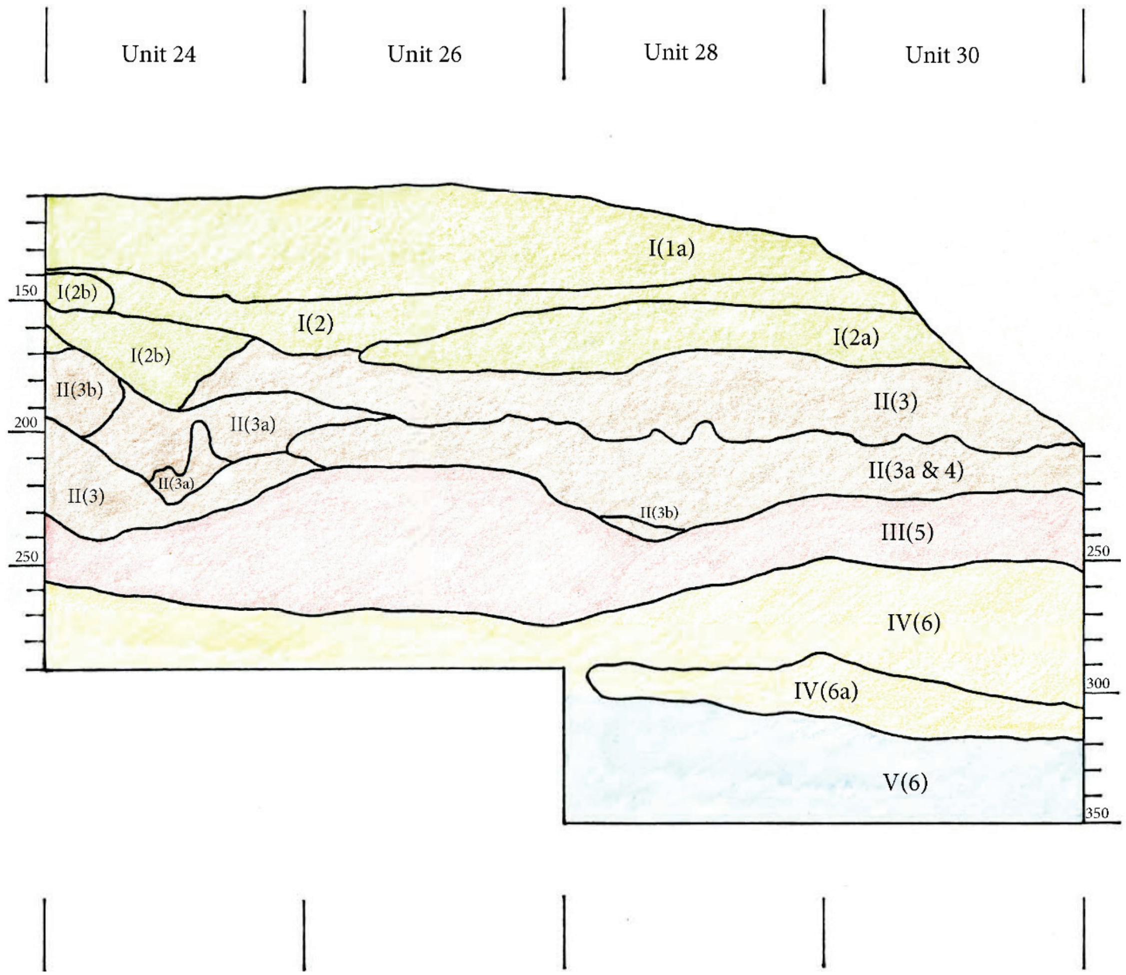


Figure 5.05. Redrafted drawing of the southern portion of the east wall of Trench 1502. Roman numerals correspond with synthesis of stratigraphy described at the end of this chapter, while numbers in parentheses correspond to the original 1971-72 layers. Top line is ground surface, bottom line is base of excavation, and polygons with X's are rocks.

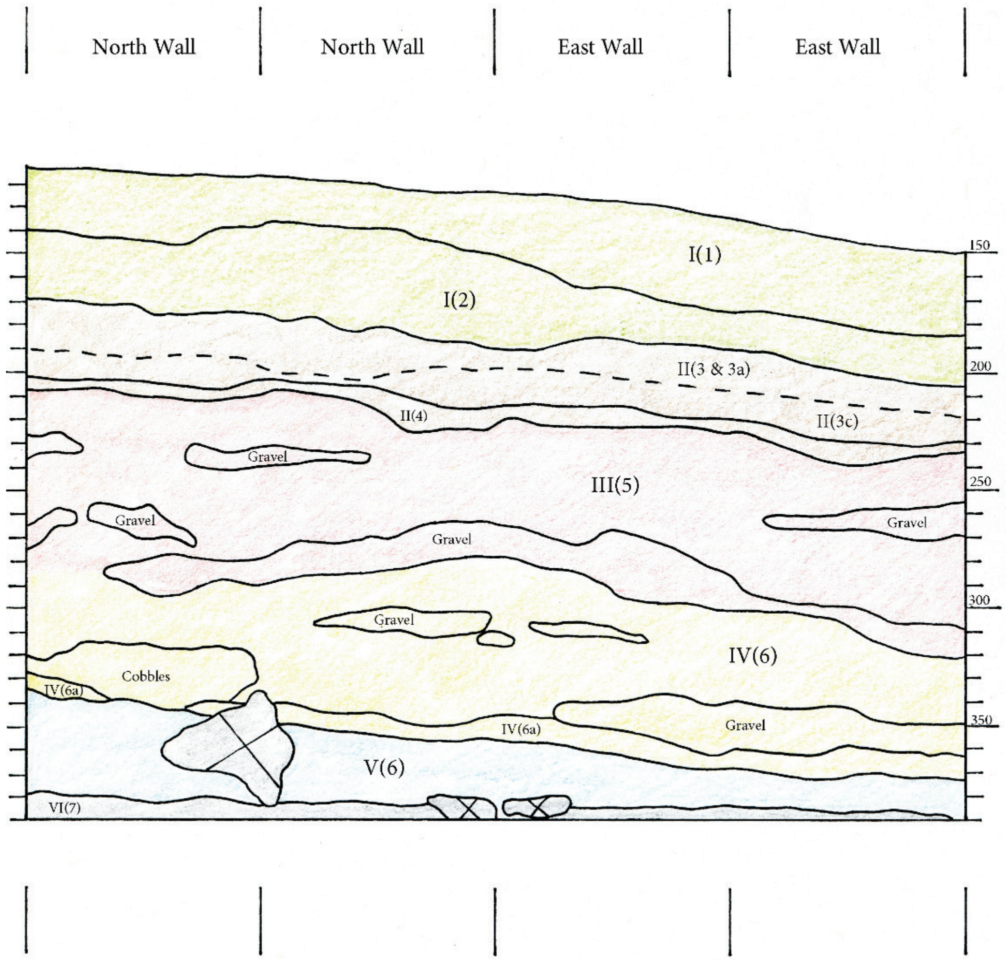


Figure 5.06. Redrafted drawing of the north and east walls of Trench 1503. Roman numerals correspond with synthesis of stratigraphy described at the end of this chapter, while numbers in parentheses correspond to the original 1971-72 layers. Top line is ground surface, bottom line is base of excavation, and polygons with X's are rocks.

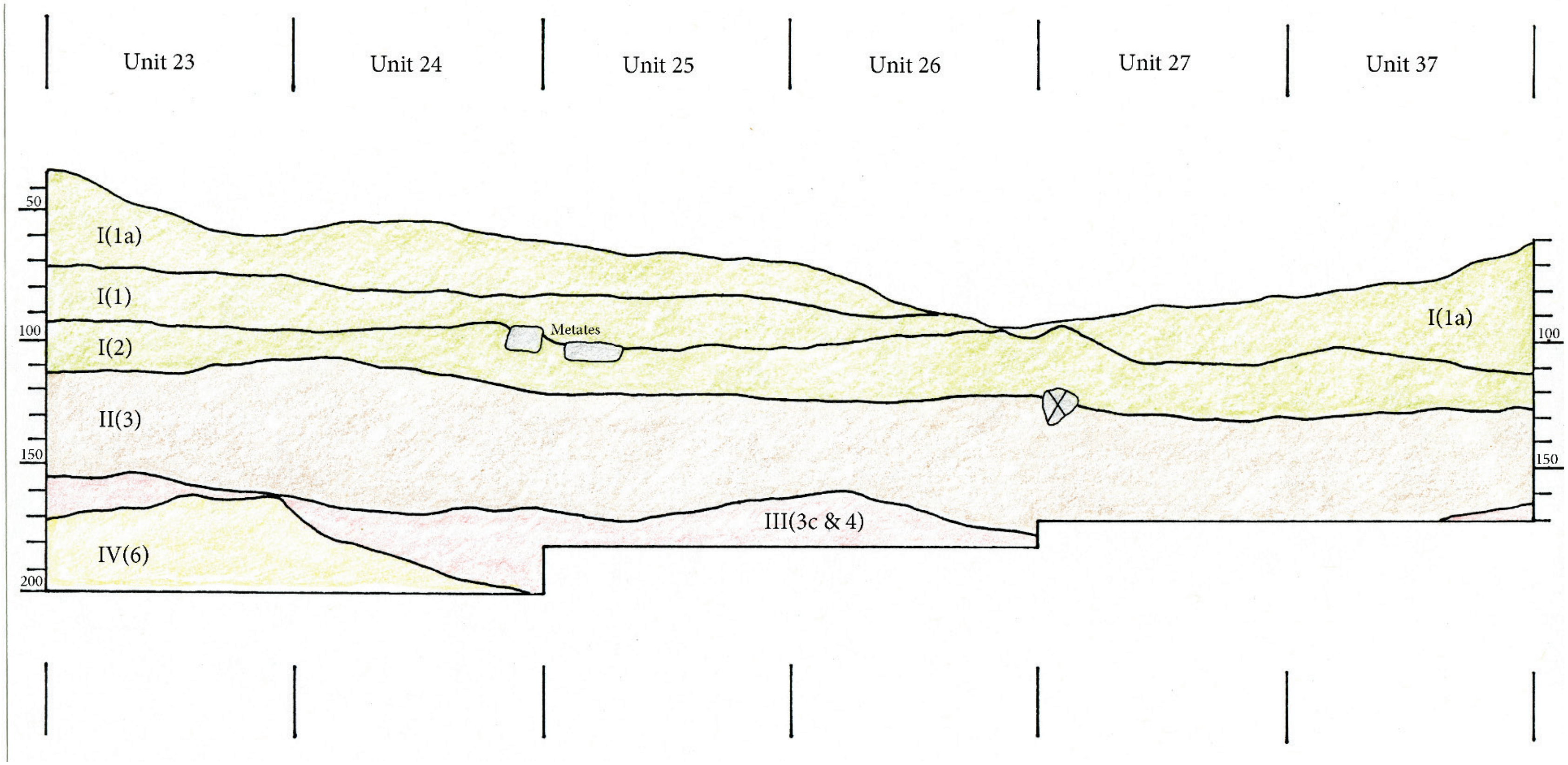


Figure 5.07. Redrafted drawing of the north wall of Trench 1504. Roman numerals correspond with synthesis of stratigraphy described at the end of this chapter, while numbers in parentheses correspond to the original 1971-72 layers. Top line is ground surface, bottom line is base of excavation, and polygons with X's are rocks.

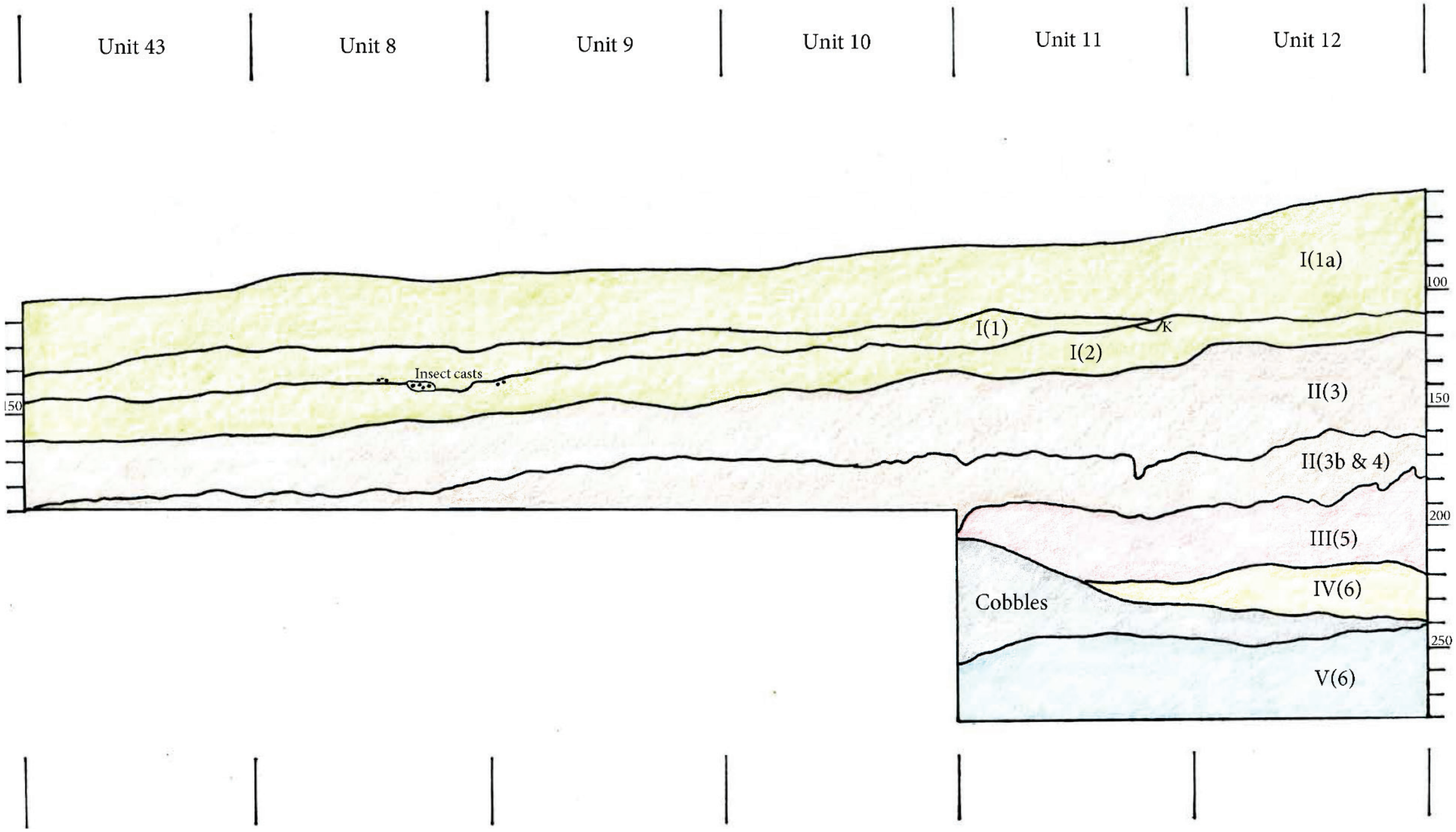


Figure 5.08. Redrafted drawing of the south wall of Trench 1504. Roman numerals correspond with synthesis of stratigraphy described at the end of this chapter, while numbers in parentheses correspond to the original 1971-72 layers. Top line is ground surface, bottom line is base of excavation, and polygons with X's are rocks.

In addition to the redrafted 1972 profile maps, I compiled textual information on the stratigraphy. Using the 1972 field notes, I characterized profiles for Trench 1503, three locations along Trench 1502, and two locations along Trench 1504. The tables compiled (Table 5.01-5.06) include stratum designation, depths below surface in centimeters, range in thickness of each stratum, the corresponding excavation levels which contain each stratum, and the descriptive terminology and noted features from the original 1971-72 profile drawings.

The notes on strata were written directly on the original profiles. In the descriptive portion of the tables below, the information listed comes from the unit selected for characterization or the surrounding units. For example, the description for the northern portion of Trench 1502, unit 9, contains information gleaned from adjacent units 8, 10, 16, and 22. Some areas of the documented profiles contained a fair amount of information jotted on the drawings while other areas were devoid of description. Excavation levels from the 1971-72 field seasons were measured below a single vertical datum adjacent to the northeast corner of Trench 1502. Therefore Level 13 in one part of the excavation corresponds to Level 13 elsewhere. Level 5, for example, has a beginning depth of 50 cm below datum and an ending depth of 60 cmbd and remains so across the site. In the following tables (5.01-5.06), I tabulated depths below surface from the drawings—this information was not part of the 1971-72 field notes.

Table 5.01. Trench 1503 Profile Description Based on the Juncture of the North and East Walls.

Stratum	Depth (cmbs)[1]	Thickness range (cm)	Level	Descriptive terminology from 1972 profile drawing
1	0-25	15-35	12-14	Dark fairly course silt or aeolian soil
2	25-65	15-40	15-18	Lighter than #1, very hard but smooth in texture
3 & 3a	65-75	10-20	19	E wall; upper portion is angular, small cobble (0-5cm) W wall; crumb structure and cobbles (1-15cm)
3c	75-90	5-35	20-21	Lower portion is caliche with the same cobble (0-5cm)
4	90-100	5-40	21-22	Light brown, very fine hard pan
5 (upper)	100-140	40-70	22-26	Light brown, very fine, soft, fairly fine poorly developed crumb structure
Cobble & caliche	140-155	0-28	26-27	Light brown, very fine, soft, no crumb structure, angular cobbles (0-10)
5 (lower)	155-220	20-65	28-34	Light brown, very fine, soft, no crumb structure
Ash	220-230	0-15	34-35	
6	230-260	12-40	35-37	Light brown, very fine soil with a fair amount of small pea gravel
7	260-270	0->15	38	Very dense cobble lens (2-10) and some large rock (<= 1m) sitting on floor

[1]Corresponding depth of excavation below datum range from approximately 120 cm to 390 cm.

Table 5.02. Trench 1502 Profile Description of the Northern Portion

Stratum	Depth (cmbs)[1]	Thickness range (cm)	Level	Descriptive terminology from 1972 profile drawing[2]
1	0-28	20-30	-1,0,1	Dark brown, fine, soft (unit 10); almost without rock (unit 22)
2	28-68	40-50	2-8	Dark brown, soft (unit 10); occasional angular rock and some large rock (unit 22)
2a	53-58	0-10	2-6	Dark brown, hard (unit 10)
3	68-78	5-10	6-8	Heavy crumb structure (units 10 & 8); very small pea gravel (unit 8)
4	78-90	20-30	7-11	Light brown, very hard (unit 10); #3 truncates into floor, if not for hard pan #4 would have a heavy crumb structure (unit 16)
6	90-138	25->48	9-13	

[1]Corresponding depth of excavation ranges from approximately 10 cm above datum to 140 cm below datum.

[2]Description based on Unit 9 west wall unless otherwise indicated. Other units may be west or east walls.

Table 5.03. Trench 1502 Profile Description of the Middle Portion

Stratum	Depth (cmbs)[1]	Thickness range (cm)	Level	Descriptive terminology from 1972 profile drawing[2]
1a	0-20	0-20	7-11	Fine silt (pot hunter's backdirt)
2	20-63	42-75	8-15	
2a	45-50	0-6	13-14	
3	63-84	18-28	15-18	
4	84-107	15-40	18-22	
4a	107-121	10-20	20-23	Same as #4 but with white and black lenses
6 upper	121-198	50-75	21-29	
6a	198-207	8-10	28-30	Ash
6	207-245	38->45	29-33	

[1]Corresponding depth of excavation ranges from approximately 75 cm to 340 cm below datum.
[2]Description based on Unit 18 east wall.

Table 5.04. Trench 1502 Profile Description of the Southern Portion

Stratum	Depth (cmbs)[1]	Thickness range (cm)	Level	Descriptive terminology from 1972 profile drawing[2]
1a	0-22	15-35	11-14	
2	22-30	5-10	14-15	
2a	30-50	18-25	15-17	
3	50-84	20-35	17-20	
3a & 4	84-115	25-40	19-23	
3b	115-123	0-8	23-24	Cobbles (unit 24)
5	115-140	25-45	22-27	
6 upper	140-170	20-35	25-29	
6a	170-182	10-25	28-30	
6 lower	182-230	40->50	29-34	Very large rock at base of excavations (unit 17)

[1]Corresponding depth of excavation ranges from approximately 110 cm to 350 cm below datum.
[2]Description based on Unit 28 east wall, unless otherwise indicated. Other units may be west or east walls.

Table 5.05. Trench 1504 Profile Description of the North Wall at the Juncture of the West wall.

Stratum	Depth (cmbs)[1]	Thickness range (cm)	Level	Descriptive terminology from 1972 profile drawing2
1a	0-40	0-50	3-7	Backdirt from looter's excavations
1	40-63	0-23	7-9	
2	63-83	10-30	9-11	2 metates in upper part of stratum in units 24 and 25
3	83-125	35-60	11-15	
3c	125-140	0-15	15-16	
4	140-170	0->40	16-19	
6	140-170	0->40	16-19	

[1]Corresponding depth of excavation ranges from approximately 30 cm to 200 cm below datum.
[2]Description based on Unit 23 north wall, unless otherwise indicated.

Table 5.06. Trench 1504: Profile Description of the South Wall at the Juncture of the West Wall

Stratum	Depth (cmbs)[1]	Thickness range (cm)	Level	Descriptive terminology from 1972 profile drawing[2]
1a	0-50	20-50	7-11	Backdirt from looter's excavations
1	50-60	0-20	10-12	Insect burrows noted at lower boundary (unit 8)
2	50-60	10-25	11-12	Insect burrows noted at upper boundary (units 8 & 9)
3	60-100	20-50	12-16	
3c & 4	100-120	20-30	16-18	
5	120-160	12-40	17-21	Krotovina noted (units 12 & 13)
6	160-178	0-22	21-23	Krotovina noted (units 12 & 13)
Cobble layer	178-181	3-50	23-24	
6	181-220	25->39	24-27	

[1]Corresponding depth of excavation ranges from approximately 70 cm to 280 cm below datum.
[2]Description based on Unit 12 north wall, unless otherwise indicated.

In addition to the information available from the profile drawings on butcher paper, some useful information about stratigraphy, sediments, and artifact distribution was available in the 1972 field notebook. This information is summarized in Table 5.07. In the notebook, it is generally not indicated who is making the comments but it appears that the notebook was used by all participants to record at least some of the excavated level information.

Table 5.07. Observations Pertinent to Strata Gleaned from 1972 Field Notebook.

Trench	Unit	Level	Stratum	Comment
1502	11	20		Krotovina noted on plan map
1502	11 & 13	20		Semi-circular areas of soft dirt on plan map. Matrix is soft with more debitage.
1502	13 & 14	21		Krotovina/burrow on plan map
1502	05 & 06	15-16		Krotovina/burrow mapped
1502	20	15		Large rocks mapped
1502	09,10,15,16	15		Plan map shows a small channel with sand and some pea gravel with silts on either side. Trends NE/SW.
1504	11	18		At bottom of level there is lens of reddish, somewhat sandy material with flecks of charcoal. Sample collected.
1504	29	12	2	Metate #1 - associated with Feature 3
1504	25	12	2	Metate #2 – associated with Feature 3
1504	24	10	2	Metate #3 – associated with Feature 3
1504	37	11	2	Metate #4 – associated with Feature 3
1504	39 & 40	14		Lens of white ash mapped. Top at 140 cm and bottom at 143 cm. Contains flecks of shell and charcoal and has marked horizontal layering. Two samples collected.
1504	11 & 12	20		Extremely hard matrix noted in NW portion of unit 11 and rocky in SW portion. Along a diagonal across both units, charcoal is noted in NE portions of both units.
1504	25	9	2	Fire pit mapped. Contains chunk of ccs, some burned bone fragments. A profile was drawn. It is 10 cm deep. May be an extension of Feature (?) from 1971 excavation in stratum 2. It contains high frequency of all cultural material.
1504	23		2	A number of rocks mapped and noted that are within Stratum 2. Bottom of Stratum 2 is 119 cmbd.
1504	G			Stream bed gravel mapped in SW corner around elevation 220 cmbd.

Cochran's Thesis Work

As part of his Master's thesis investigation of Johnson Canyon Quaternary stratigraphy, Bruce Cochran (1978) characterized two areas of the Sanders excavation. The first was not labeled but is assumed to be from the lower or southern portion of Trench 1502 based on the depth of the profile and character of the description. The second is labeled "West End" and therefore presumed to be along the south or west wall of Trench 1504. Profile drawings do not accompany either description. The depths listed on the profile descriptions are much deeper than that attained during excavation. This presumably means he went out to the site and re-exposed the trench walls, excavating deeper than the original 1971-72 fieldwork in order to better characterize the underlying stratigraphy. (As stated in the methods section of my thesis, the Sanders excavation remained open since there was no dirt left for backfilling.)

In his work, Cochran named depositional units from bottom to top in the canyon, from A at the base (but not expressed in the Sander's Creek site) through G at the top of the undisturbed sediments. These were called "units." It should be noted that his Unit designations are based on depositional episodes and used to help interpret Johnson Canyon stratigraphy and not Sanders per se. A composite sketch was created for Johnson Canyon at the Sanders site and appears as Figure 7 on page 21 of his Master's Thesis. Tables 5.08 and 5.09 summarize his descriptions of stratigraphy at the Sander's site.

Table 5.08. Profile Characterization at Sanders Site from Cochran (1978)[1]

Unit	Thickness (cm)	Description
	0-3	Dark brown (10YR 3/3,m), fine sand, brown (10YR 5/3,d); platy; loose, nonsticky, nonplastic; many fine and medium roots; many fine interstitial pores; about 10% angular pebbles; redeposited cultural debris from amateur excavations; abrupt, smooth boundary to;
	3-21	Very dark grayish brown (10YR 3/2,m) coarse silt and fine sand, dark grayish brown (10YR 4/2,d); loose, nonsticky, nonplastic; many fine and medium roots; many fine interstitial pores; about 10% angular pebbles; reworked cultural debris from amateur excavations; abrupt, smooth boundary to;
G	21-30	Dark brown (10YR 3/3,m) silt and fine sand, brown (10YR 5/3,d); weak, fine subangular blocky breaking to crumb; loose, very friable, nonsticky, nonplastic; many fine roots; many fine interstitial pores; lower portion slightly effervescent; late prehistoric cultural material *in situ*; clear, way boundary to;
G	30-44	Dark brown (10YR 3/3,m) course silt and fine sand, pale brown (10YR 6/3,d); weak, fine platy structure; slightly hard, very friable, nonsticky, nonplastic; few fine roots; many very fine interstitial and few fine tubular pores; pores filled with calcium carbonate; strongly effervescent; late prehistoric cultural debris; clear, wavy boundary to;
F	44-74	Dark brown (10YR 3/3,m) fine sand and silt, brown (10YR 5/3,d); moderate medium to fine crumb breaking to single grain; loose, nonsticky, nonplastic; few medium roots; many medium tubular pores; cultural material; about 20% angular pebbles; clear, wavy boundary to;
F	74-120	Dark brown (10YR 4/3,m) fine sand and silt, pale brown (10YR 6/3,d); massive; soft, very friable, nonsticky, nonplastic; common fine roots; many fine interstitial, vesicular, and tubular pores; cultural material; slightly effervescent; abrupt, wavy boundary to;
D	120-180	Brown (10YR 5/3,m) silt and fine sand, very pale brown (10YR 7/3,d); massive; soft, very friable, nonsticky, nonplastic; very few fine roots; many fine and few medium tubular pores; cultural material; common medium prominent yellowish red (5YR 4/8,d) mottles; gradual, wavy boundary to;
D	180-230	Brown (10YR 5/3,m) silt and fine sand, very pale brown (10YR 7/3,d); platy structure; soft, very friable, nonsticky, nonplastic; very few fine roots; many fine and few medium tubular pores; common fine and medium prominent yellowish red (10YR 4/8,d) mottles; abrupt, wavy boundary to;
C	230-245	Pebble gravel with coarse sand interstitial fill; abrupt boundary to;
B	245-310	Brown (10YR 4/3,m) coarse silt and fine sand, pale brown (10YR 6/3,d); weak, fine subangular blocky breaking to single grain; soft, very friable, nonsticky, nonplastic; very few fine and very fine roots; few large tubular pores; many large distinct yellowish red (5YR 4/8,d) mottles coating ped surfaces; about 10% manganese nodules (5YR 2/2,d) 2-4 mm in diameter; cultural material; depth unknown.

[1]Summarized from Cochran 1978:78-79. The location within the site is not noted, but I suspect it is from the eastern portion near the creek, given that Cochran did not note bedrock at a shallower depth.

Table 5.09. Profile Characterization from "West End" of Sanders Site by Cochran (1978).

Unit	Thickness (cm)	Description
	0-12	Dark brown (10YR 3/3,m), fine sand, brown (10YR 5/3,d); weak, medium crumb breaking to single grain; soft, loose, nonsticky, nonplastic; many fine and medium roots; many fine interstitial pores; reworked cultural debris from amateur excavations; abrupt, wavy boundary to;
G	12-22	Dark yellowish brown (10YR 3/4,m) fine sand and silts, yellowish brown (10YR 5/4,d); laminated structure; soft, very friable, nonsticky, nonplastic; many fine roots; many medium and fine tubular pores; cultural material; slightly effervescent; abrupt, wavy boundary to;
F	22-45	Very dark brown (10YR 2/3,m) coarse silts and sand, dark yellowish brown (10YR 4/4,d); weak, fine crumb breaking to single grain; soft, very friable, nonsticky, nonplastic; common fine roots; many fine interstitial pores; clear, irregular boundary to;
F	45-80	Dark brown (10YR 3/3,m) silt and fine sand, brown (10YR 5/3,d); laminated structure; slightly hard, friable, nonsticky, nonplastic; few fine roots; few medium and fine tubular pores; cultural debris; strongly effervescent; clear, smooth boundary to;
F	80-108	Dark yellowish brown (10YR 4/4,m) silt and fine sand, pale brown (10YR 6/3,d); massive; slightly hard, friable, nonsticky, nonplastic; very few fine roots; few fine and very few medium tubular and many fine interstitial pores; few rodent burrow, 10-15 cm in diameter; slightly effervescent; clear, wavy boundary to;
F	108-155	Dark brown (10YR 3/2,m) silts and sand, grayish brown (10YR 5/2,d); moderate fine crumb breaking to single grain; soft, very friable, nonsticky, nonplastic; few medium and fine roots; few fine interstitial pores; abrupt boundary on pebble line to;
E	155-160	Pebble gravel with coarse sand interstitial fill; abrupt smooth boundary to;
D3	160-195	Dark brown (10YR 3/3,m) sand and silt, brown (10YR 5/3,d); massive platy structure; soft, very friable, nonsticky, nonplastic; very few fine roots; very few fine tubular pores; gradual, wavy boundary to;
D3	195-375	Dark yellowish brown (10YR 4/4,m) coarse silt and fine sand, pale brown (10YR 6/3,d); massive platy structure; soft, very friable, nonsticky, nonplastic; very few fine tubular pores; common medium prominent yellowish red (5YR 3/2,d); abrupt, smooth boundary to;
C	375+	Basaltic gravels; rounded to subrounded.

[1]Summarized from Cochran 1978:80-81. The location within the site is not noted specifically, but the "west end" is presumably from Trench 1504 toward the creek.

Besides a field investigation, Cochran also performed some laboratory work to help with interpretation of the canyon. The samples include radiocarbon and tephra samples from a number of his described Localities which were processed at WSU. None of the samples were collected from the Sanders site.

2012 Field Characterization

Following is a profile characterization of the southern portion of the west wall of Trench 1504. It is the result of my investigation of Sanders stratigraphy completed in the spring of 2012. The project was undertaken to augment my understanding of the stratigraphy as recorded in the original profile of 1971-72.

The profile had to be stepped because of the angle of the slumped walls. Created a vertical face from top to bottom would also have been more work than time permitted and would have disturbed a larger portion of the site sediments. Predicting the depth of the floor of the original excavation was by approximation. My profile indicates that I faced about 20 cm below the original floor. I was not able to characterize the upper portion of the profile because the loose sediments continued to slump.

Table 5.10. Description of 1504 West Wall from 2012[1]

Stratum	Depth (cmbs)	Description
NA	0-75	Slump from modern surface
VIII	75-90	Dark yellowish brown (10YR 4/4 moist); moderately well sorted silt loam; massive; blocky, sub-angular, weak; friable; 5-10% sub-round granules and pebbles < 3cm in diameter; strong HCL reaction - Stage I; abrupt smooth boundary.
VII	90-115	Dark yellowish brown (10YR 3/4 to 4/4 moist); moderately well sorted silt loam; massive; blocky, sub-angular, weak; friable; 5-10% sub-rounded granules; strong HCL reaction - Stage I; abrupt smooth boundary.
VI	115-125	Dark yellowish brown (10YR 4/4 to 4/6 moist); moderately well sorted fine sandy, silt loam; massive; blocky, sub-angular, weak; friable; 5% sub-rounded granules; strong HCL reaction - Stage I; abrupt smooth boundary.
V	125-170	Dark yellowish brown (10YR 3/4 to 4/4 (moist); moderately well sorted silt loam; massive; blocky, sub-angular, moderate; firm; 5-10% sub-rounded granules and pebbles < 3cm in diameter; $CaCO_3$ mottling and concretions (< .5cm) throughout layer; strong HCL reaction - Stage II; abrupt undulating boundary
IV	170-205	Dark yellowish brown (10YR 3/4 moist); moderately well sorted fine sandy silt loam; massive; blocky, sub-angular, weak; friable; 5-10% sub-rounded granules and pebbles < 3cm in diameter; slight HCL reaction - Stage I; clear undulating boundary.
III	205-220	Dark yellowish brown (10YR 3/4 moist); moderately well to poorly sorted fine sandy silt loam massive; blocky, sub-angular, weak; friable; 5-10% sub-rounded granules and pebbles < 2cm in diameter; clear undulating boundary.
II	220-240	Dark brown to dark yellowish brown (10YR 3/3 to 3/4 moist); moderately well sorted silt loam; massive; blocky, sub-angular, weak; friable; no gravels; clear undulating boundary.
I	240-260	Dark yellowish brown (10YR 3/4 moist); moderately well sorted silt loam; massive; blocky, sub-angular, moderate; firm; 5% sub-round granules; 20% iron oxide mottling and streaks. Mottles; dark brown 10YR 3/3 moist; < .5cm in diameter.

[1] at approximately the northern half of Unit 13.

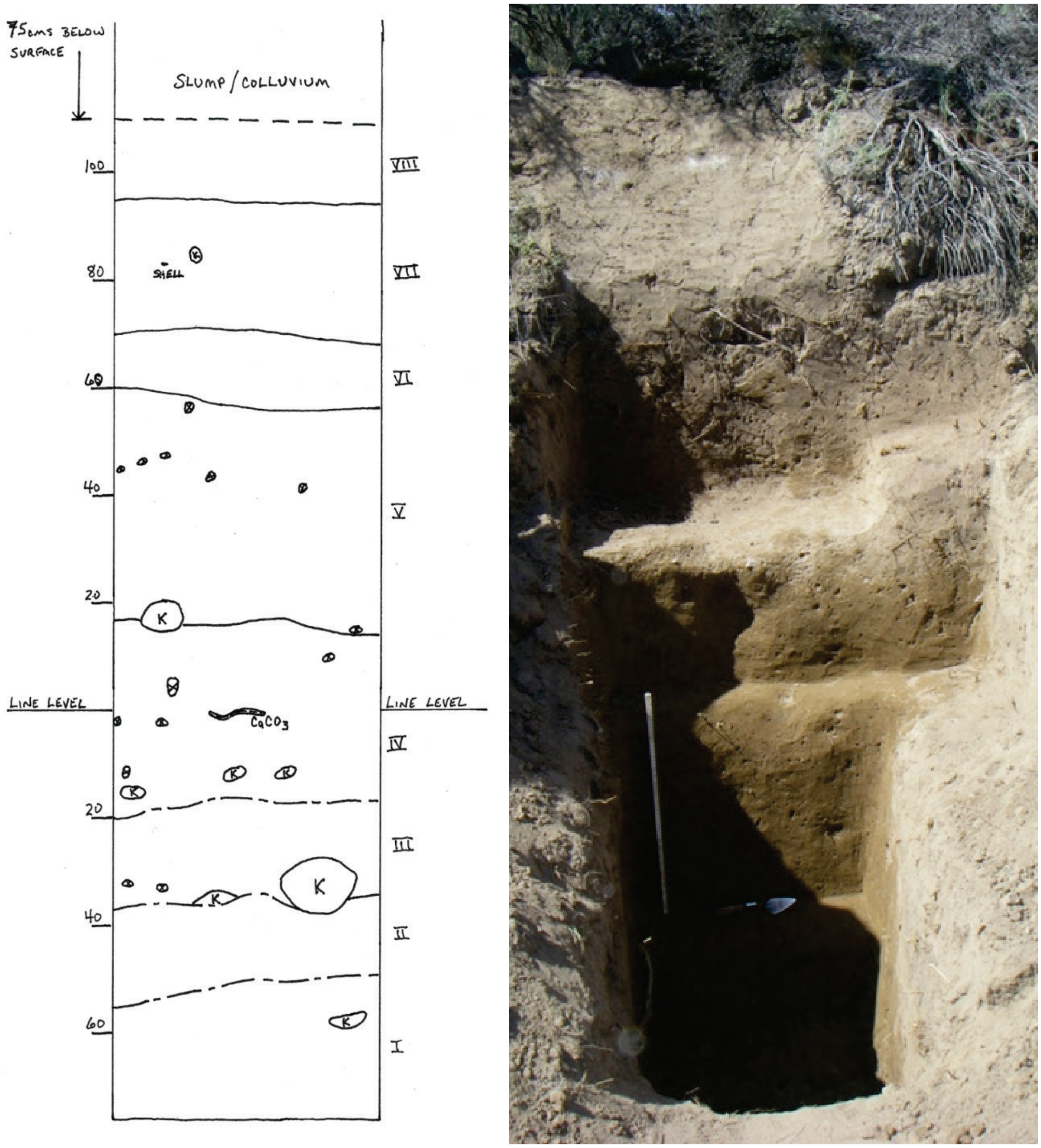


Figure 5.09. Map of 2012 profile and corresponding photograph.

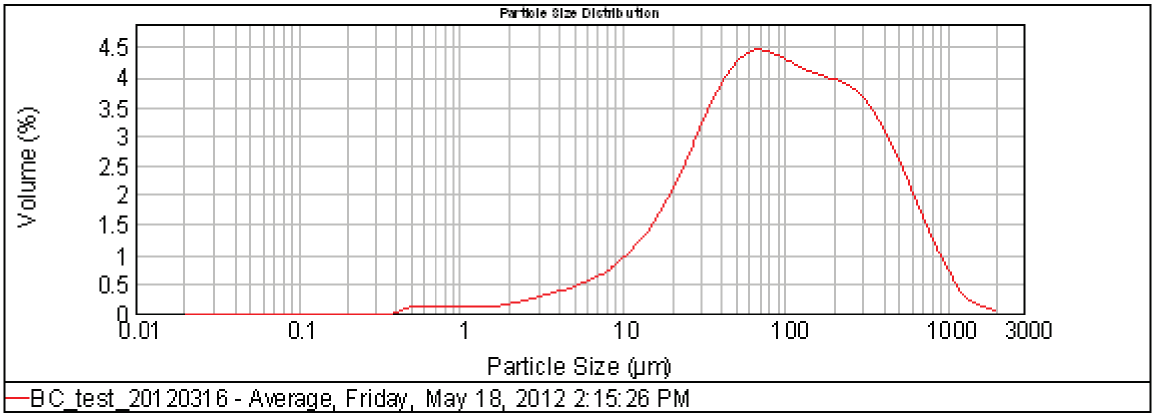
2012 Laboratory Analysis

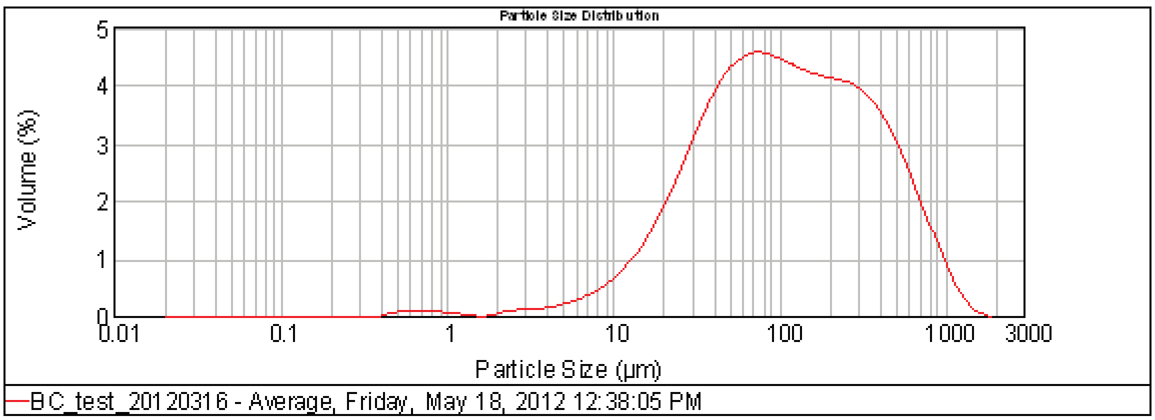
Processing samples for the distribution of particle size was undertaken in 2012 as part of the examination of west wall of Trench 1504. The objective was to use the data to help sort out the depositional environment responsible for the stratigraphy. It was observed on an earlier field trip that the sediments were generally fine grained. The source of the fine sediments is a question that has important consequences for landform history and site formation processes. Distinguishing aeolian dune and sheet sediments from stream slack water or overbank accumulation therefore became an important goal. A strong caution was issued by Boggs (2001) when interpreting results of particle size analysis to identify depositional environments. Though there is a considerable amount of literature relating grain size to specific modes of deposition, the relationships remain unclearly defined.

The particle size distribution output from the Mastersizer for each defined 2012 stratum is provided in Figures 5.10-5.12. The frequency curve graphs are plotted in micrometers or microns. One micron equals one thousandth of a millimeter. The Wentworth grain-size scale for sediments was used to describe the distribution.

Table 5.11. Wentworth Particle Size Classes Listed in Millimeters and Microns. Modified from Boggs (2001.Table 3.1 p.62).

Particle Size Class	Millimeters (Range)	Microns (Range)
Coarse sand	1.00-0.50	1000-500
Medium sand	0.50-0.25	500-250
Fine sand	0.25-0.125	250-125
Very fine sand	0.125-0.0625	125-62.5
Coarse silt	0.0625-0.031	62.5-31
Medium silt	0.031-0.0156	31-15.6
Fine silt	0.0156-0.0078	15.6-7.8
Very fine silt	0.0078-0.0039	7.8-3.9
Clay	<0.0039	<3.9





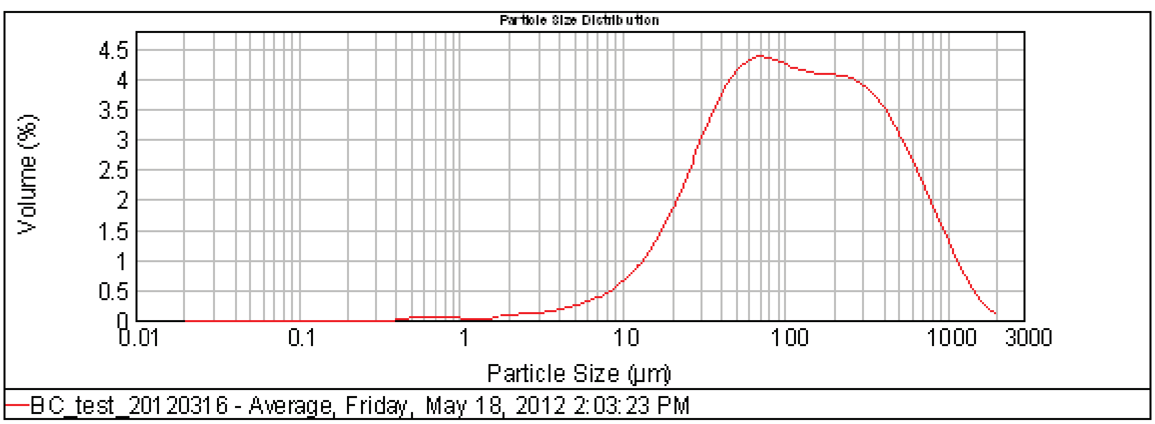


Figure 5.10. Particle size distributions for Strata VIII (top), VII (middle), and VI (bottom). These distributions correspond with the Wentworth grain size scale as follows: VIII silty fine sand, VII silty fine sand, VI silty fine sand.

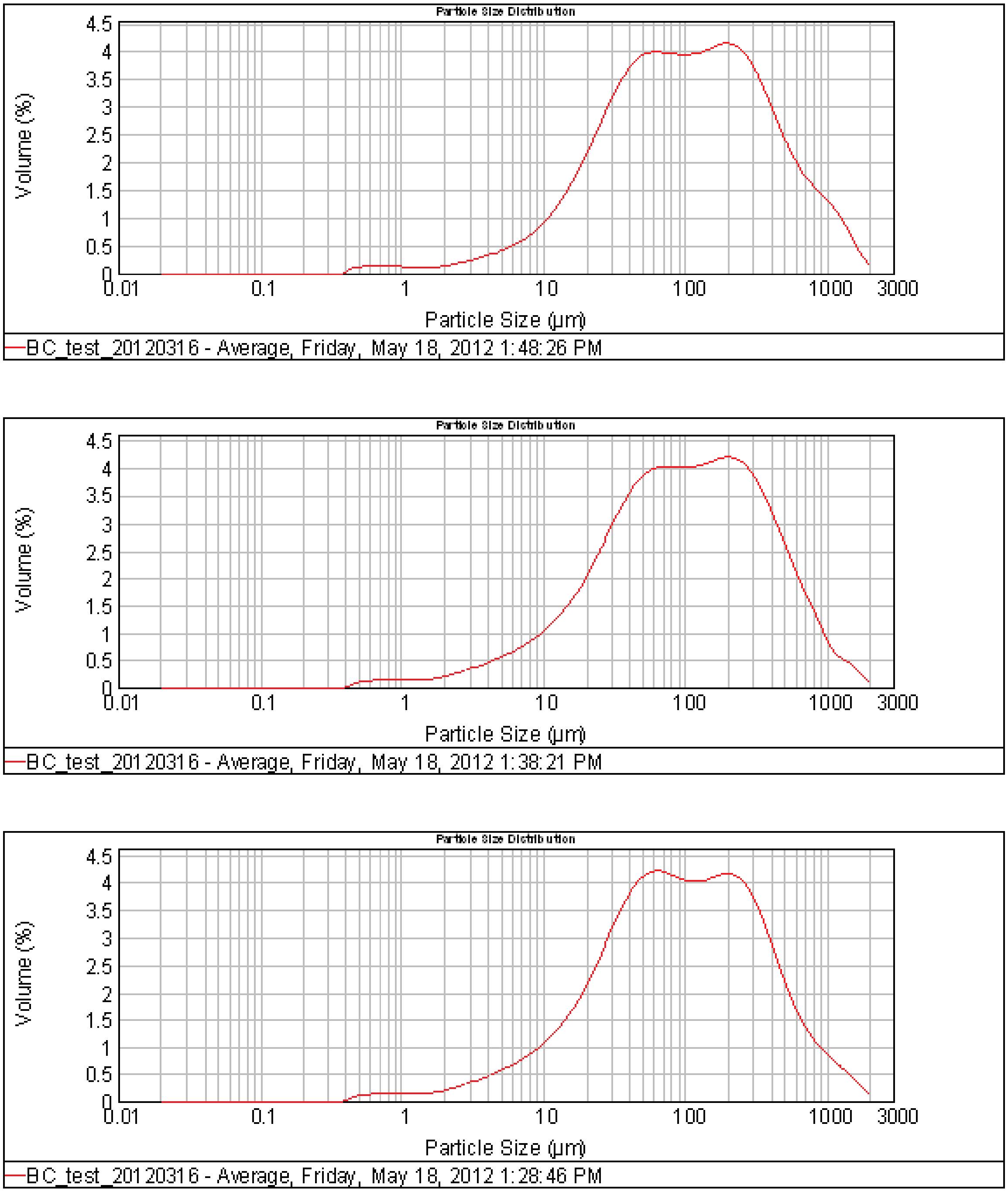
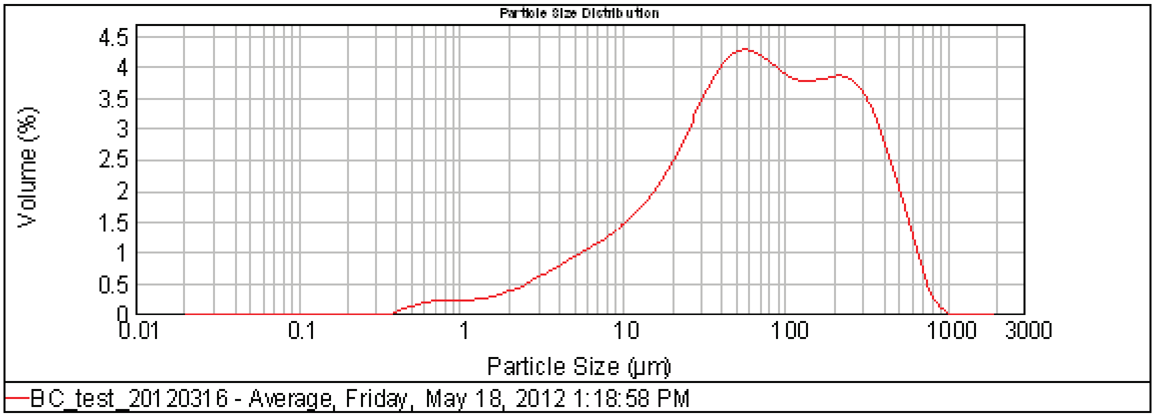


Figure 5.11. Particle size distributions for Strata V (top), IV (middle), and III (bottom). These distributions correspond with the Wentworth grain size scale as follows: V silty sand, IV silty sand, III silty sand.



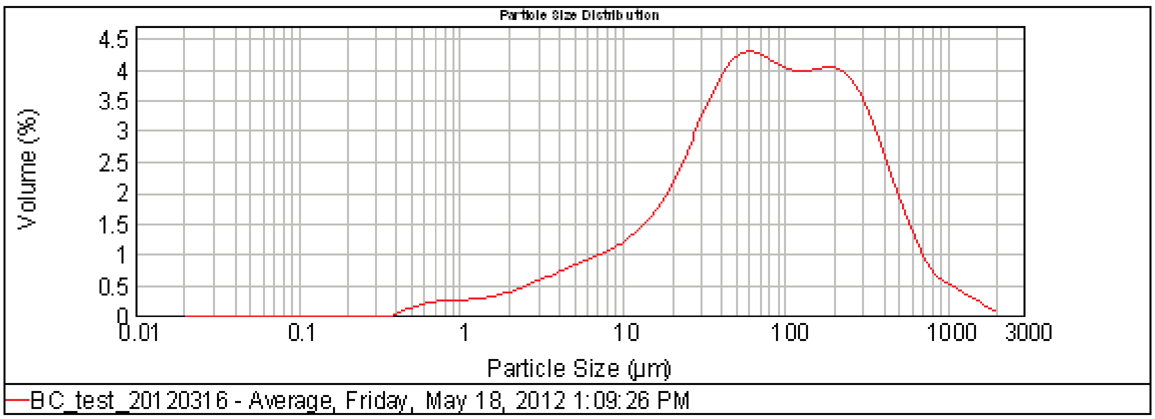


Figure 5.12. Particle size distributions for Strata II (top) and I (bottom). These distributions correspond with the Wentworth grain size scale as follows: II slightly loamy silty sand, I slightly loamy silty sand.

Synthesis of Stratigraphy

Below I synthesize the stratigraphic information for the site, including layer designation correspondence, textural characteristics, soil development, spatial distribution, geochronology, and cultural material for each stratum. Strata are described from the surface down to the bottom of the excavated profile in 1971-72. Stratigraphic information pertaining to depths below the original excavation described by Cochran (1978) will be included in the discussion of site formation in the following chapter.

Stratum I is the uppermost stratum. It includes Layers 1, 1a, 2, 2a, and 2b from the original profiles, the undesignated layers and Unit G of Cochran, and the upper portion of the "slump" of the 2012 profile. Sediments consist of silts and fine sands which conformably overlie Stratum II. The constituent layers are thickest in the northern portion of Trench 1502 and thin somewhat south toward the creek. Elsewhere, in Trenches 1503 and 1504 the layers generally have a consistent thickness. Layer 2b in Trench 1502 intertongues with layer 1 from the south, becoming discontinuous toward the north. Soils developed in the sediments comprise an A-Bk sequence. The A horizon is thickest in the south and western part of the site. The B horizon is thickest in the north and eastern part of the site. The calcic accumulation in the B horizon is well developed and very hard. Layer 1 is the backdirt from looter's excavations and contains matrix of Layers 1, 2, and possibly 3. Associated cultural materials are late pre-contact and are consistent with Cayuse Phase artifacts from the region. Dated bone from the lower portions of this stratum suggest a raw age about 3000 BP (Vantine 2009).

Stratum II includes Layers 3, 3a, 3b, parts of 3c, and 4 of the original profiles, designated Unit F from Cochran, and VIII, VII, and VI from the 2012 profile. The boundary with the lower stratum is a disconformity. Sediments consist of dark fine grained silts and sands in Layer 3 in the southern and western parts of the site with some fine gravels in the north and east. Layer 3 has variable thickness but tends to thin toward the north and east. Below Layer 3 is the gravelly facies of 3a, 3b, and 3c. These layers are discontinuous with variable thickness and texture. They are scour and fill features from small channels. Layer 4 is both gravelly and fine grained. Its defining characteristic being calcium carbonate accumulation. A well-developed soil consisting of an A-Bk-Bk2 sequence is traceable across the site within these layers. The lower boundaries of these layers is highly bioturbated. Associated cultural material includes Frenchman Springs and Cascade Phases. Dated bone from this layer gives a raw age of about 2900 BP (Gray 1999).

Stratum III consists of Layer 5 and part of Layers 3c and 4 of the original profiles, Unit F from Cochran, and VI from the 2012 profile. The sediments consists of brown silty fine sands with variable fine gravel content. The lower boundary with Stratum IV is a disconformity. The layers are discontinuous across the site. Soil formation is

Figure 5.13. Pedestalled Feature 2 from Trench 1504 in 1972 excavations. Note well-expressed soil A-horizon in profile walls just above the level of the artifacts. This is the soil in Stratum II. Img169.

characterized by weak blocky ped formation. Associated cultural material consists of Frenchman Springs and Vantage Phase artifacts. Two dates on bone recovered from this stratum in Trench 1504 give a raw ages between about 3500 BP and 4900 BP (Ainsley). Figure 5.13 illustrates a cultural feature in association with this Stratum III.

Stratum IV includes Layers 6 (upper portion) and 6a (tephra) of the original profiles, Unit and D from Cochran, and V from the 2012 profile. Parts of this stratum in the northern part of the site may conformably overlie Stratum V, but in the southern portion the boundary is marked by a disconformity. Coincident with the disconformity, the tephra layer is absent from the profile. In the southern wall of Trench 1504 the boundary is defined by a gravel layer. The sediments of Stratum IV are brown silty sands. Associated cultural material consists of Vantage Phase artifacts. Two dates on bone from this stratum give widely ranging raw dates of about 2900 BP and 8800 BP (Dice 2009; Ainsley 2010).

Stratum V includes the lower portion of Layer 6 of the original profiles, designated Unit D from Cochran, and IV, III, and II from the 2012 profile. The sediments consist of dark yellowish brown slightly loamy to silty sand. It contains some fine gravel in the northern portion of the site. This stratum was only reached in the more deeply excavated units. Associated cultural material consists of Vantage and Windust Phase artifacts. The only date from this stratum comes from bone near the base of the excavation in Trench 1502 and returned a raw date of about 9350 BP (Dice 2009).

Stratum VI includes Layer 7 of the original profiles. This stratum consists of cobbly basalt residuum and was encountered at the base of excavations in Trench 1503.

The large rock at the bottom of excavation Unit 17 in the northern part of Trench 1502 may be bedrock.

The 1971-1972 excavations defined Strata I-V, but some later investigations dug below Stratum V. Cochran (1978) designated Units B, C, and D below Stratum V. In my own 2012 profile, I defined layer I below Stratum V.

CHAPTER VI

DISCUSSION

The discussion below is divided into three topics. First, I create a summary of site formation, including deposition and soil formation. This involved consideration of the sediment profiles at the site, much like the original excavators in Figure 6.01. Second, I attempt to correlate Sanders Site geoarchaeology with site 45KT726 across the creek. Finally, I attempt to correlate the Sanders Site with the Yakima Training Center alluvial chronology.

Site Formation

There are a number of depositional processes interacting at the Sanders site, including fluvial, colluvial, and aeolian, expressed in loess, reworked alluvium, and tephra. Fluvial processes are responsible for deposition of alluvium, which composes some of the site sediments, especially in the narrow floodplain along Sanders Creek. These alluvial sediments interfinger with aeolian and colluvial sediments at the site. Aeolian sediments include Pleistocene loess and perhaps small amounts of more recent dust and sand, and are more strongly expressed in the western part of the site. Colluvial sediments derive from the slope to the northwest of the site. These sediments are a mixture of fine-grained material, perhaps reworked alluvium and loess, and coarser materials including broken basalt bedrock. Colluvium accumulations are greater in the northern and eastern part of site.

Figure 6.01. Bruce Cochran and an unidentified student discussing an excavation profile wall in 1972. Img128.

A photo of the southwest corner of Trench 1504 is compared with the original profile from 1972 (see Figure 6.02). In Figure 6.02 I compare my strata designation with those drawn in the original drawing. Here I outline the stratigraphic sequence from bottom to top as related to site formation. The lowest depositional stratum excavated by the 1971-72 field crews, Stratum V (Layer 6), consists of fine grained alluvium. The sediments are consistent with overbank or slack water deposits and likely indicates a

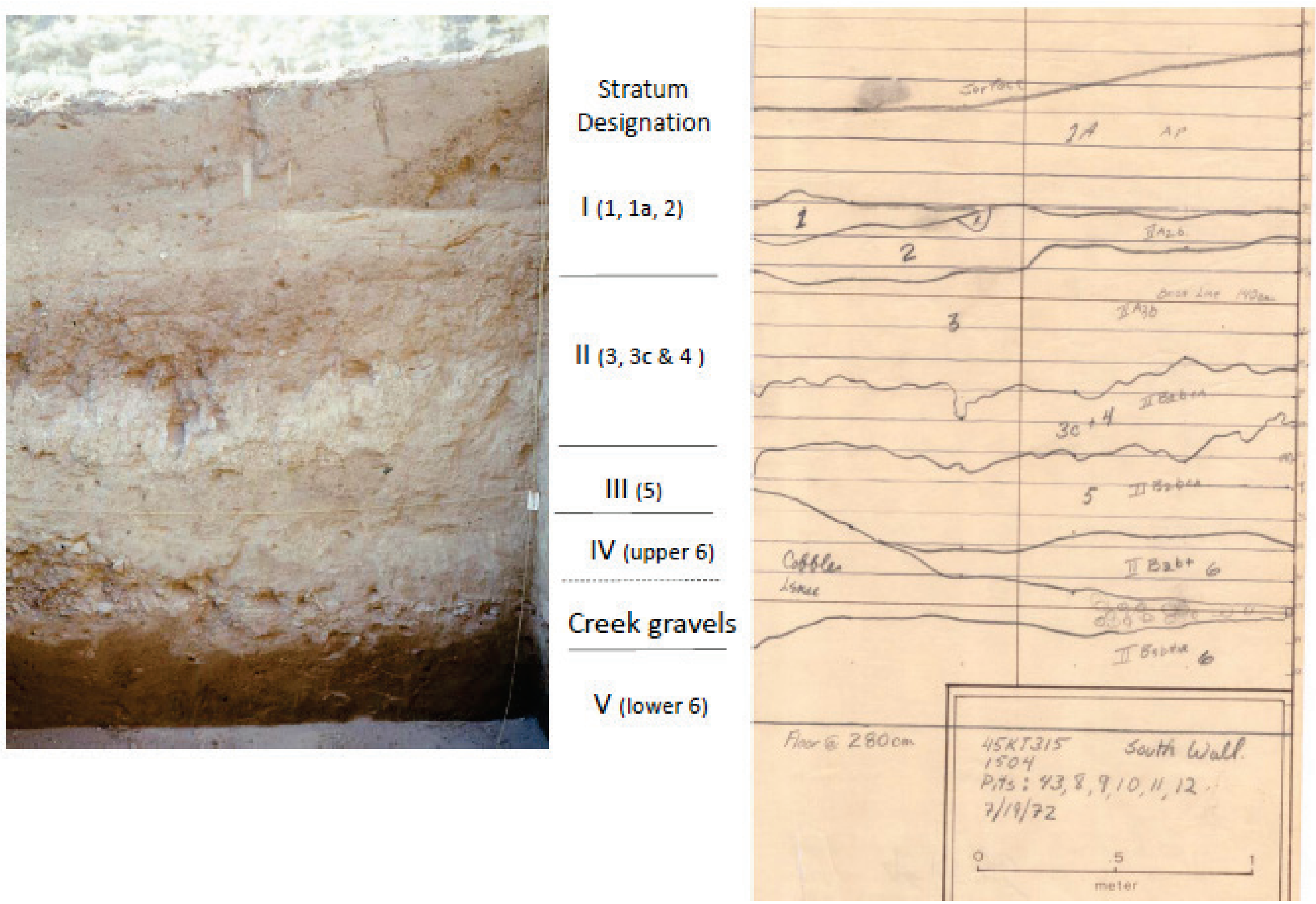


Figure 6.02. Photo and profile of southwest corner of Trench 1504. Authors strata designated by Roman numeral with original designation in parentheses.

period when Johnson Creek was aggrading. The sediments were accumulating prior to the eruption of Mt. Mazama. Nest to the creek, an unknown amount of this stratum was eroded by scour.

Stratum IV begins with Mt. Mazama tephra (unverified) which marks a period of renewed accumulation. At least the upper portion of the tephra is reworked by slope wash and aeolian processes. Sediment accumulation of fine alluvium continues until before approximately 5000 BP as indicated by the date from the above Stratum III.

Stratum III marks a period of alluvial erosion and reworking of fine sediment which began approximately 5000 BP and continued until before about 3000 BP. The sediments on site consist of scour and fill features in the southern portion of the site which merges with sheetwash colluvium in the upslope position. The upper boundary is cut by a renewed period of scour and fill.

Stratum II begins with scour and fill of the southern portion of the site and gravelly colluvium in the upslope portion of the site. This erosive activity if followed by the deposition fine alluvium near the creek and aeolian and slopewash to the north, upslope. A well-developed soil marks a period of non-deposition which persisted until approximately 2900 BP based on dated bone. However, the artifacts recovered seem to indicate a date that is closer to 2500 BP.

Stratum I is fine grained and marks the final period of alluviation which persisted into the historic period. The sediments also include aeolian deposition and sheet wash from upslope. Sedimentation appears to have been quick at first to bury the soil of

Stratum II. The over-thickened A horizon in the southern portion of the site seems to indicated a slow and steady accumulation of sediments thereafter.

In several of the 1971-1972 unit profiles, excavators identified a tephra at the base of Stratum IV. This tephra was presumed to be Mazama based on stratigraphic position (designated as “ash” or “Layer 6a”) and thickness (~8-25 cm). No samples of this material were ever submitted for chemical characterization or verification that it is in fact Mazama tephra from the site. However, a sample from directly across the creek at 45KT726 in primary context was verified as Mazama by Nick Foit of the Washington State University Microbeam Laboratory (Gough and Ives 2002:C.2). The Mazama eruption was at about 6850 BP according to Foit (Gough and Ives 2002:C.2) or 7600 cal BP based on Bayesian modeling of the radiocarbon dating set (Egan et al. 2015).

There are several clearly defined soils in the Sanders Site excavated sediments. Two soils are well defined and there may be indications of eroded or more weakly expressed soil horizons. The upper soil is the modern soil that is weathered into Stratum I. The lower soil is associated with the Frenchman Springs archaeological material in Stratum II.

The soil associated with Stratum I consists of an A-Bk sequence and has a dark brown A horizon with weak fine granular structure. The B horizon consists of a light brown, very hard calcic horizon. The A horizon may be over-thickened due to local aeolian deposition. In illustration, tephra from the 1980 eruption of Mt. St. Helens (unverified) lies approximately 15 cm below the surface at the western wall of Trench 1504.

The Stratum II soil is similar to the overlying soil of the modern surface and has an A-Bk-Bw sequence. The A horizon is dark brown and has a weak to moderate fine granular structure. It is thick in the western and southern portion of the site but thins upslope. The upper Bk (calcic) horizon is light in color, well formed, and very hard. It is thinner in the southern and western portions of the site and thickens in the uphill direction. The lower Bw horizon has a weak subangular blocky structure.

Soils below this are difficult to define without examination of the profiles at the site. In his composite sketch of Johnson Canyon at Sanders locale, Cochran (1978) illustrates 3 periods of soil formation. The first two of these likely match the two soils discussed for the excavation above. The third lies below Mazama ash, and may relate to regional soils defined by Lenz.

Lenz et al. (2007) have defined two pre-Mazama soils in the Columbia Plateau. The Bishop Paleosol is well expressed throughout the Columbia Basin (and beyond) and has a typical sequence of A-Bw or Bt. Formation began after eruption of Mt. St. Helens Set S tephra (~12,800 BP) and continued until burial by Glacier Peak tephra. The Badger Paleosol post-dates Glacier Peak and predates the Mazama eruption, and consist of multiple stacked A-Bw or Bt horizons that may overprint the earlier soil.

Comparable soils at Sanders are poorly expressed or absent due to geomorphic processes. In Trenches 1502 and 1503 at Sanders, Stratum IV and V are divided by a layer of Mazama ash, Layer 6a from the original profiles. The sediments in Trench 1503 indicate that this part of the landform was active during this time. The sediments consist of numerous discontinuous layers and lenses of gravelly colluvium interbedded with fine grained aeolian deposition. Therefore soil formation is very weak or has been eroded. This tephra layer (6a) is absent in the western part of the site – Trench 1504. However, in the north portion of the west wall of Trench 1504 Stratum IV and V are divided by channel gravels. I believe Mazama was stripped by the creek in the western portion of the site. Cochran (1978) makes no mention of Mazama or tephra being in the western portion of the site that he described. However, he does include Mazama in his composite sketch for Johnson Creek at the Sanders Locality (Cohran 1978:21) and a soil formed below.

Stan Gough (1999, Gough and Ives 2002) indicates that the sediments on the south side of the creek at 45KT726 likely post-date 5800 B.P. He did, however, locate a primary deposit of Mazama in the south end of backhoe Trench 1 (Gough and Ives 2002:9). It had been truncated by the creek and is restricted to the southern bank of the canyon.

The preservation of buried archaeological remains along Johnson Creek was assessed by Galm et al (2000), concluding that the middle and upper portions of the canyon had the greatest potential for old sites. This is due to the Holocene re-working of sediments in the lower part of Johnson Canyon. The older dates from the Sanders Site illustrate that potential. Site formation and preservation of sediments at the site appear to be related to multiple geomorphological factors or controls. Johnson Creek is influenced by sediment from the nearest upstream ephemeral tributary. The influx of sediment and large size of the clasts push the channel of Johnson Creek toward the south side of the valley and away from the site (Gough 1999). A bedrock outcrop on the north side of creek just upstream creates a small spur in the valley margin which diverts the channel away from the site (Gough 1999), which may offer further protection from erosion. Fine sediment accumulation at the site may relate to fan development (Miller et al 2001). A fan on the south side of the creek just downstream of the site changes the base level of the channel, creating an area of slower flow velocity causing the stream to drop sediment upstream in the vicinity of the site. Subsequent build-up of sediment on and behind the fan which causes a rise in the base level of the channel will eventually cause incision (Miller et al 2001).

Correlation with 45KT726

Geomorphic events at Sanders and across the creek at 45KT726 show similar site formation processes over approximately the last 5000 years. However much of the south side of the valley has been stripped of early Holocene sediments as evident by the lenticular gravel layers and geochronology (Gough 1999; Gough and Ives 2002). Sediments of greater age are present in their Trench 3 profile beneath Mazama tephra in primary depositional context. These sediments are probably restricted to the southern wall of Johnson Canyon along this stretch of the creek. See Figure 6.03 for a summary of stratigraphy at 45KT726.

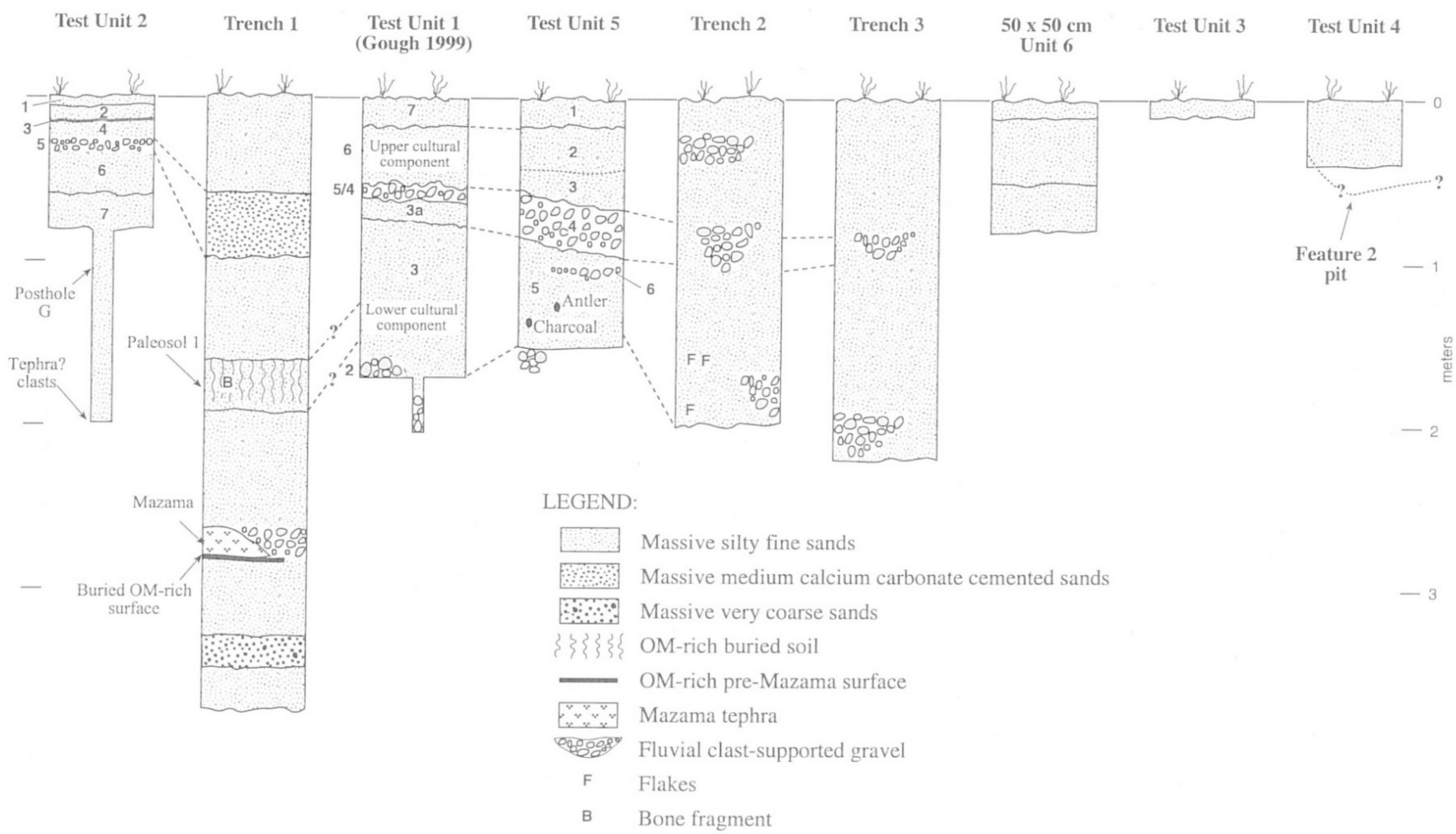


Figure 6.03. Stratigraphic profiles from 45KT726 (Gough and Ives 2002: Figure 4).

Cultural material below Mazama was not observed in the limited exposure at 45KT726. However its presence in primary context certainly indicates the potential for early Holocene artifacts. The sediments in the middle part of the canyon at 45KT726 preserve cultural materials representing the Frenchman Springs and Cayuse Phases. While the two cultural phases are separated by alluvium in this part of the canyon, at Sanders sediments of the Cayuse Phase lie directly atop Frenchman Springs Phase deposits (Figure 6.04). Despite the thicker accumulation of alluvium at 45KT726 during the last 5000 years, the Sanders landform is roughly equal in elevation. Recovered cultural material and radiocarbon age ranges for the cultural material at 45KT726 are in line with those from bone samples at Sanders.

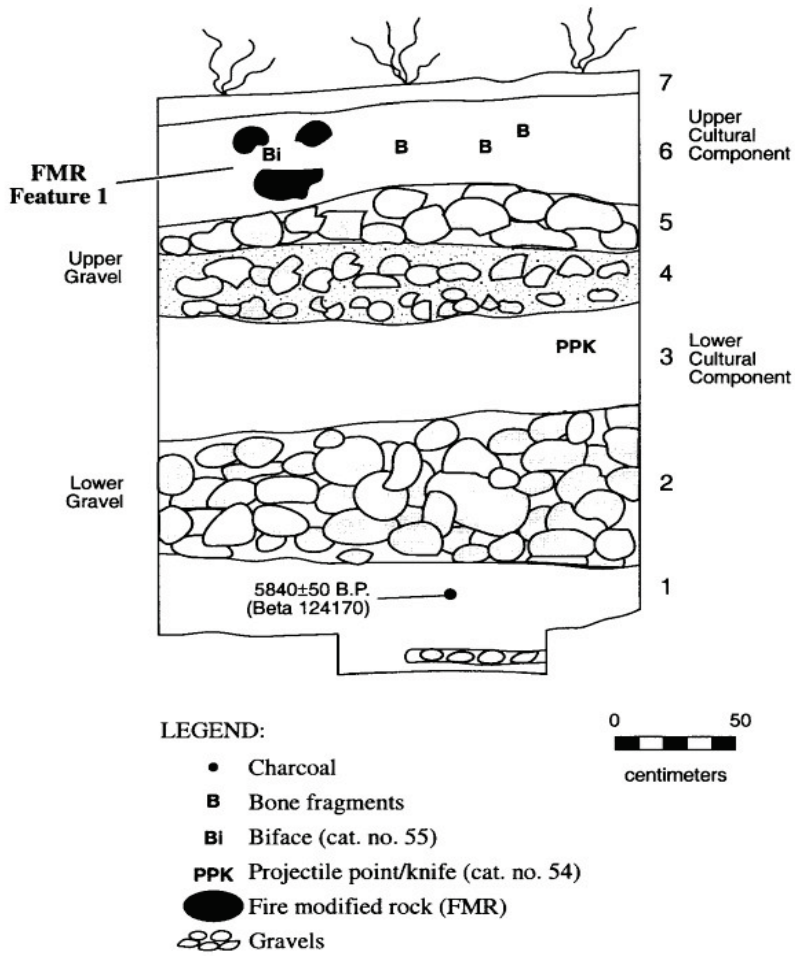


Figure 6.04. Profile illustration from 45KT726 (Gough 1999, Figure 19, p50) showing Upper Cultural Component (Cayuse Phase) and Lower Cultural Component (Frenchman Springs Phase).

Correlation with Alluvial Cycles

Causes of incision and aggradation of channels in semi-arid and arid environments have been reviewed elsewhere in Bull (1997) and more recently in Schumm (2005), who also include humid environments. A review of causes of arroyo formation is not provided here; the purpose is to highlight the cyclic nature and underlying importance for YTC alluvial cycles outlined by Galm et al (2000). The Fogoil chronology refines the periods of aggradation and incision observed and reported by Cochran (1978), work he did for his Master's thesis on the Quaternary stratigraphy in Johnson Canyon. The cycles Cochran (1978) described were discussed in relation to regional environmental trends and alluvial chronologies constructed elsewhere in the Columbia Plateau physiographic province, such as Hammatt (1977) on the lower Snake River. However, a cautionary note on matching alluvial cycles in small upland watersheds to regional trends issued by Schumm (2005).

It is difficult to reconcile alluviation in one part a watershed with that of other parts, based on geomorphic work at archaeological projects along Johnson Creek (Gough 1996, 1999; Gough and Ives 2002). However, stratigraphy at Sanders summarized above does give a general indication of periods of aggradation, stability, and degradation. Alluvial cycles are defined by incision followed by alluviation. During periods when the valley floodplain is stable, soils have time to form. Incised or degraded phases are marked by a lowering of the water table, resulting in less vegetation bordering streams and poor soil forming conditions. Deep incision is not indicated in the stratigraphy at

Sanders. There are, however, periods of erosive fluvial activity indicated by more localized scour and fill.

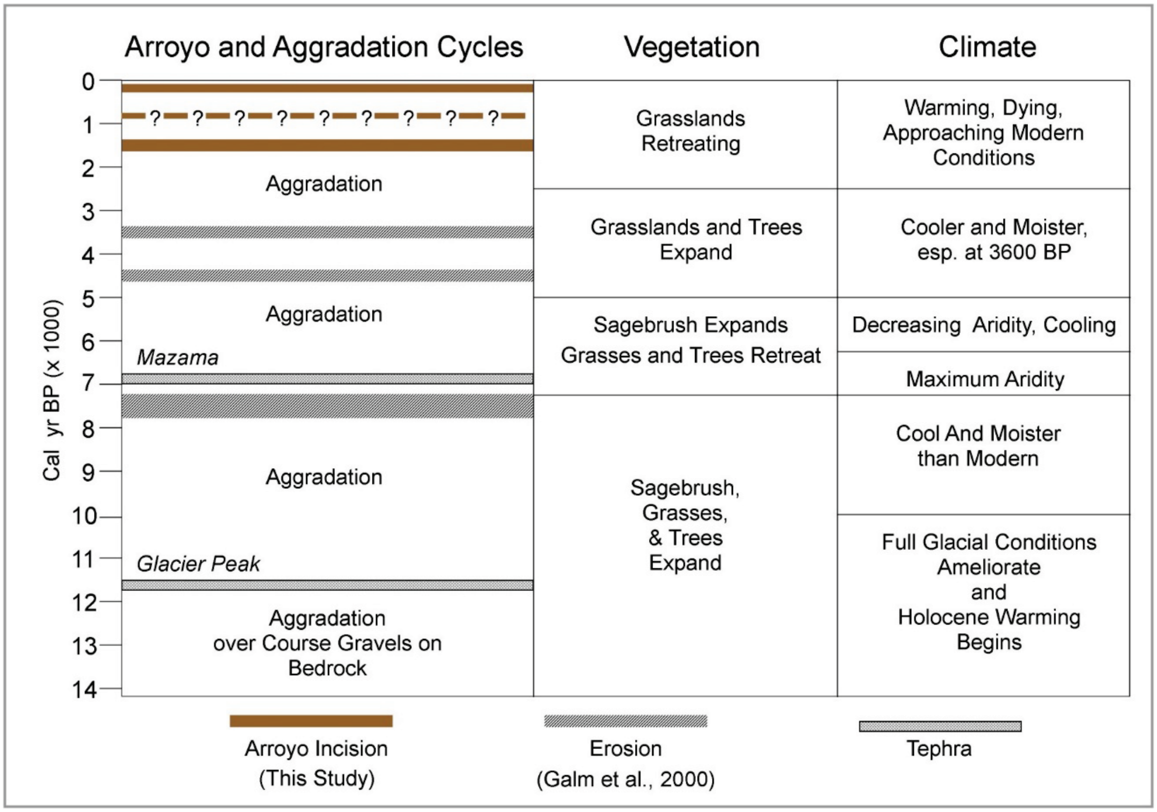


Figure 6.05. Regional Alluvial Chronology and Paleoclimate (Durkee and Ely 2009). Illustrates the Four Alluvial Cycles Identified by Gam et al. (2000).

Four alluvial cycles were identified by Galm et al. (2000) and are presented in Figure 6.05 above. Sediments exposed in Stratum V during the 1971-72 excavation at Sanders correspond to the later part of the first Aggradation Cycle. As indicated above, tephra from the Mazama eruption are only partially preserved at Sanders in Stratum IV. It is unknown when the portion of the site adjacent to Johnson Creek began eroding, either before Mazama or after its deposition. Post-Mazama aggradation, Stratum IV, is better preserved in the upslope portions of the Sanders profiles and corresponds to the second Aggradation Cycle. The upper portion of this stratum was eroded by channel and slope processes sometime before 4900 BP to 3500 PB, which begins the next Aggradation Cycle. This period of aggradation has a smaller time frame and may be represented by Stratum III at Sanders which begins after about 5000 BP and ends before 3000 BP. This period is followed by the last Aggradation Cycle identified by Galm et al. (2000). However, like Durkee and Ely (2009) Sanders sediments as well as those at 45KT726 indicate another incision at after about 2900 BP to 1500 BP followed by aggradation. There are certainly some overlap of broad patterns. However, more dates to constrain the timing of sedimentation is needed to better correlate Sanders stratigraphy with aggradation cycles throughout the YTC. See Figure 6.06 for a view of the Johnson Creek arroyo in 1972 and a scar from a paleochannel indicating a past alluvial regime.

Figure 6.06. Overview of 1972 excavations with Johnson Creek arroyo and paleochannel scar in background. Img049.

CHAPTER VII

CONCLUSIONS

Summary of Findings

The 1971-72 excavations at Sanders unearthed cultural material in preserved sediments spanning the Holocene, and maybe older, as excavation was still recovering artifacts in lowest levels. Cochran (1978) also notes artifacts in his documentation of the Sanders stratigraphy at depths below those attained during formal excavation.

Though excavated in 10 cm levels, Dr. Smith and his team put considerable effort into associating recovered cultural material to identified strata. Without his attention, this project, as well as continued work with the Sanders collection, would suffer greatly. The geoarchaeological summary presented here depended greatly on Dr. Smith and the 1971 and 1972 field crews.

The site is occupied repeatedly throughout the Holocene based on radiometric dates and artifact styles assigned to culture history phases. Fluctuation in numbers of artifacts is generally tied to intensity of occupation. There may well be an increase of use or population represented by increase in artifact totals between Windust and Frenchman Springs phases. However, since there is continuity of use through all phases, it may be that the footprint of the occupation shifted, probably based on channel configuration. That shift, if true, does not appear to be preserved due to channel erosion – early Holocene sediments are stripped out of much of valley. Fan development downstream influenced the base level of the creek resulting in the long history of deposition at the site, while upstream geomorphic controls on stream flow have protected the site from erosion.

The preservation of buried archaeological remains along Johnson Creek was assessed by Galm et al (2000), who concluded that the middle and upper portions of the canyon had the greatest potential for old sites. This is due to the Holocene re-working of sediments in the lower part of Johnson Canyon. The older dates from the Sanders Site illustrate that potential. Site formation and preservation of sediments at the site appear to be related to multiple geomorphological factors or controls.

Johnson Creek is influenced by sediment from the nearest upstream ephemeral tributary. The influx of sediment and large size of the clasts push the channel of Johnson Creek toward the south side of the valley and away from the site (Gough 1999). A bedrock outcrop on the north side of the creek (see Figure 2.04) just upstream creates a small spur in the valley margin which diverts the channel away from the site (Gough 1999), offering further protection from erosion. Fine sediment accumulation at the site may relate to fan development (Miller et al. 2001).

A fan on the south side of the creek just downstream of the site changes the base level of the channel, creating an area of slower flow velocity causing the stream to drop sediment upstream in the vicinity of the site. Subsequent build-up of sediment on and behind the fan which causes a rise in the base level of the channel will eventually cause incision (Miller et al 2001).

Significance and Limitations

Recovered cultural material from the Sanders site spans the Holocene. These include the Windust and Frenchman Springs Phases, which are rare in a buried context on the YTC (Davis 2017). Gough (2002) notes that Sanders and 45KT726 across the creek are the only excavated along the middle portion of Johnson Creek. Sanders was the first and remains one of the largest excavations on the YTC. The others are located in the upper reaches of the Johnson Creek watershed (Gough 1996).

In my opinion, archaeology is a field-based science. The vast majority of the information about Sanders stratigraphy is based on the work of others. Other documents are missing from the collection. This lack, coupled with the fact that I did not have ready access to the site, made characterization and interpretation of the stratigraphy difficult.

During the limited time spent at the site I was plagued by several problems. Lack of spatial control was due to the condition of the trench and foresight on my part. At the least, a 50 meter tape and compass would have made a huge difference. Secondly, I could only expose a very limited area for profiling because of the amount of shoveling involved and not wanting to further disturb in situ cultural deposits. Finally, I was not prepared to take good photographs.

Recommendations

The focus of this thesis was on stratigraphy and site formation. Moving forward with analysis and student projects, it would be helpful to have unit summaries, feature descriptions, table of samples collected, series of block plan maps at different levels or corresponding strata. Other things I think would be worth doing for future work on this site include (1) more dates on Sanders stratigraphy as well as timing of geomorphic events along creek., (2) more stratigraphic investigation, especially looking at the north side of creek above and below Sanders, and the high bank directly across from Sanders defined by paleo-channel, (3) work to understand to the development of the alluvial just downstream of the site and its effect on base level and channel behavior.

This is an important site that need to be protected for future investigations. Its location on the YTC confers some good initial protection from people, but it is in danger of erosion, both in the exposed excavation trenches (Figure 7.01), and possible future incision of the creek. I recommend backfilling the excavation trenches as a start for stabilization, and perhaps fortifying the creek bank to prevent erosion there.

Figure 7.01. Sanders site in May 2017. This shot is courtesy of Bradley Esperanza, a student in the Spring 2017 Anth 323 Field Archaeology course under the direction of Dr. Steve Hackenberger.

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