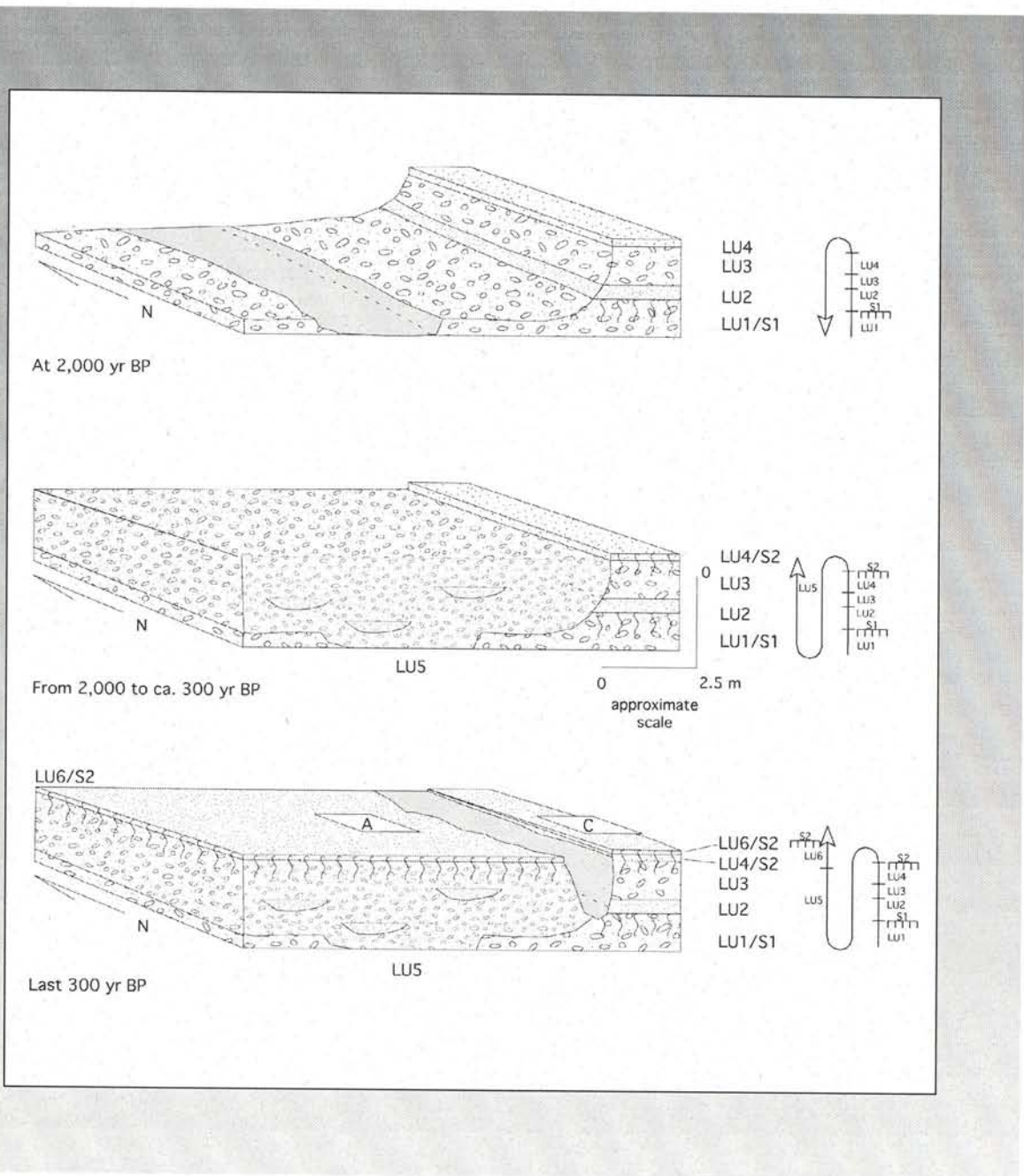


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Cover Photo: Block diagrams showing the inferred evolution of the Gill Gulch fan in the area of 10IH1308 between 2,000 B.P. and the last 300 B.P.

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ARTICLES AND REPORTS

GEOARCHAEOLOGICAL LESSONS FROM AN ALLUVIAL FAN IN THE LOWER SALMON RIVER CANYON, IDAHO

Loren G. Davis

ABSTRACT

Archaeological and geoarchaeological investigations at the Gill Gulch site (10IH1308), located in an alluvial fan deposit along the lower Salmon River canyon of western Idaho, reveal a complex natural and cultural stratigraphy spanning the middle to late Holocene periods. Stratigraphic correlation, coupled with radiocarbon-dated samples in site deposits, help to highlight the role that cycles of erosion and deposition played in the creation and alteration of site deposits and its archaeological record. An interpretation of the cultural sequence at Gill Gulch site is provided by a presentation and interpretation of various aspects of site stratigraphy, including lithostratigraphy, pedostratigraphy, allostratigraphy, chronostratigraphy, and cultural stratigraphy. There are also dangers in the application of relative tephrochronological dating to alluvial fan sites. Multiple modes of stratigraphic interpretation are offered to illustrate the potential complexity of alluvial fan sites and the problems they might hold for archaeological interpretation. Ultimately, this paper attempts to highlight some of the potential pitfalls that are associated with interpretations of alluvial fan stratigraphy and cultural chronology.

INTRODUCTION

Archaeological sites are commonly associated with alluvial fans in Idaho and elsewhere. In the semi-arid canyons common to Idaho's landscape, alluvial fans often provide microenvironmental conditions that are more favorable to plants and animals than offered by the surrounding landscape. People, too, benefited from the enhanced environmental qualities of alluvial fans. Thus, archaeological sites are commonly found on and in alluvial fans. Moreover, in many Idaho river canyons, alluvial fans may provide the only extensive and long-lasting surficial geology; and therefore represent a critical repository for archaeological sites.

Although ubiquitous and archaeologically-important landscape features, the complex formation histories often associated with alluvial fan sites can present significant challenges to archaeologists as they attempt to untangle the sequences of deposition, erosion, and past cultural occupation they contain. In the summer of 2000, the au-

thor led University of Alberta archaeological fieldschool excavations at the Gill Gulch site (10IH1308). Located on and in an alluvial fan positioned along the lower Salmon River, this site presented unique challenges for archaeological interpretation. In order to better appreciate the processes that can influence archaeological records contained in alluvial fans, I offer a cautionary tale of sorts, based on the results of archaeological and geoarchaeological research conducted at the Gill Gulch site. This tale is based on a review of the site stratigraphy of the Gill Gulch site, which provides a means of illustrating some of the challenges and concerns involved in excavating archaeological sites contained in alluvial fans. The guiding focus that underlies the reason for this paper lies in the appreciation that alluvial fans are dynamic geologic environments that influence archaeological sites and the information they contain in different ways. By highlighting some of the natural factors and processes associated with alluvial fans, I hope to bring attention to the potential pitfalls that lie ahead of archaeologists as they work to understand cultural records from these important and interesting landforms.

BACKGROUND AND GEOLOGIC SETTING

The Gill Gulch site is located within a large alluvial fan deposit that originates from the distal end of Gill Gulch, which is located about three miles upriver from the confluence of Rock Creek and the Salmon River (Figure 1). Several distinct lobes of unconsolidated surficial material, which are thought to represent shifting phases of fan deposition that form a larger fan complex, can be identified from airphotos. Stream channels have incised into the surface of the fan in several places, while only one appears to be active at this time. Bedrock in the Gill Gulch basin is almost entirely composed of Grande Ronde basalt (Gaston and Bennett 1979), with some interbedded cemented sands and silts of the Latah Formation (Kirkham and Johnson 1929).

The fact that the Gill Gulch fan is one of the largest in the lower Salmon River canyon (LSRC) likely reflects the influence of local bedrock structural behavior in the production and storage of clastic sediments. Gaston and Bennett (1979) project a dip-slip fault line trending

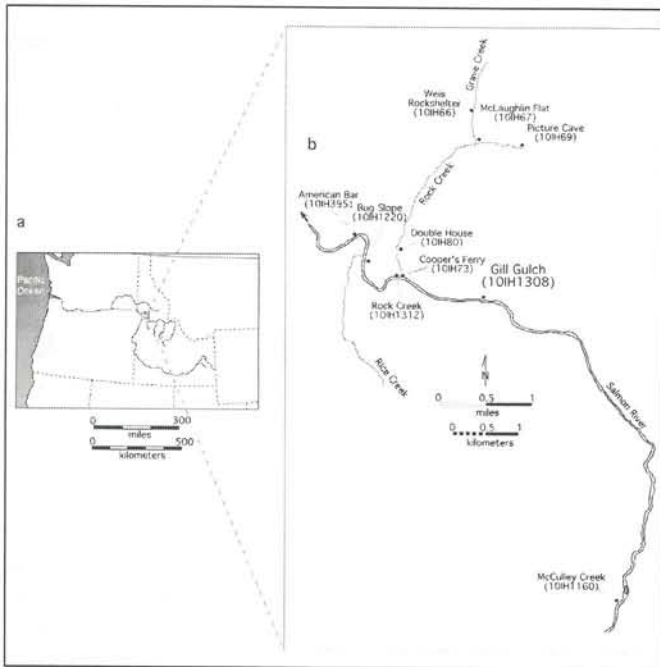


Figure 1. Map showing the location of the lower Salmon River canyon (a) and the Gill Gulch site (b), in relation to regional geography and its proximity to other sites in the canyon.

roughly north-south, located about 0.5 miles from the headwaters of Gill Gulch. Erosion along tributary stream channels extending up into the uplifted portion of the canyon wall would be expected to be accelerated, producing large amounts of clastic sediment. Because Gill Gulch lies on the downthrown side of this fault, its basin will likely store large quantities of the sediment produced. This situation can explain the presence of large alluvial fan deposits in the Gill Gulch basin.

Readers interested in learning more about approaches to interpreting depositional environments of archaeological sites should read Waters' (1992) text on geoarchaeology, and the edited volumes on archaeological sediments and earth science approaches in archaeology by Stein and Farrand (2001) and Goldberg et al. (2001). Other important sources specifically relevant to alluvial fans and sedimentary basins in general include the writings of Beaty (1990), Bull (1963, 1964, 1968, 1977), R.A. Davis (1983), Lecce (1990), Miall (1990), Reineck and Singh (1980), and Ritter (1986).

Davis (2001b) provides a detailed study of late Quaternary surficial geology and presents a middle Pleistocene to Holocene model of paleoenvironmental change on the basis of stratigraphic records from geologic sections found in the 36 kilometer section of canyon between Hammer Creek and American Bar (Figure 1). Davis' (2001b) model identifies the role of landslides and sudden movement along fault lines as important influences on riverine hydrology and riparian ecology. Davis and Muehlenbachs (2001) present a late Pleistocene to Holocene model of paleoprecipitation, based on changes in the oxygen-16/18 ratios of freshwater river mussel shell carbonates recovered from stratigraphic sequences in several LSRC archaeological sites. This paleoprecipitation record shows several periods of

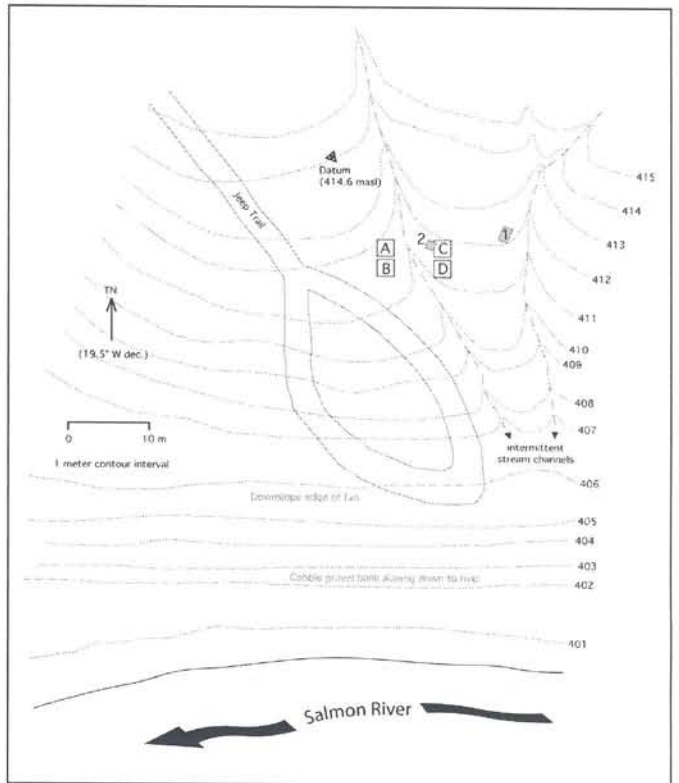


Figure 2. Site map, showing location of excavation units.

drier-than and wetter-than modern climatic conditions during the past 12,000 yr B.P. Davis et al. (2002) construct a record of paleoclimatic and paleovegetation conditions from stable oxygen and carbon isotopes of soil carbonates and aeolian sediments found in stratified canyon slope and floodplain deposits. Combined, the works of Davis (2001b), Davis and Muehlenbachs (2001) and Davis et al. (2002) provide a foundation for understanding the history of landscape, environmental, and climatic conditions and their change during the late Quaternary. These records are useful for building locally relevant interpretations of site-level geoarchaeological patterns.

STRATIGRAPHIC RECORD

Geologic deposits encountered during excavations at the Gill Gulch site were described in a manner that allows for the construction of a detailed stratigraphic record. Lithologic, sedimentological, and pedological aspects of stratigraphic units were described from field observations and laboratory data using guidelines and nomenclature outlined by the USDA Soil Survey Division Staff (1993) and Birkeland (1984). The texture of sediments was established through hand texturing and by dry sieving with a Ro-Tap shaker and nested sieves. Following stratigraphic convention (NACOSN 1983), the geologic record at 10IH1308 is characterized according to its lithostratigraphic, pedostratigraphic, allostratigraphic, and chronostratigraphic aspects. Each of these aspects are defined as they are introduced. With a natural stratigraphic framework in place, the distribution of cultural materials is summarized as a cultural stratigraphy and related to the entire stratigraphic record.

Lithostratigraphy and Lithofacies

Lithostratigraphic units (LU) are defined from site stratigraphy solely on the basis of sediment qualities. Six different lithostratigraphic units were identified in exposures at 10IH1308 (Figure 3), similar to those described by Dickerson (1997) during previous Bureau of Land Management (BLM) test excavations. The lithostratigraphy of 10IH1308 is dominated by coarse basaltic clastic sediments, which likely originated from upslope bedrock deposits in the Gill Gulch tributary basin. Interpretations of the geomorphic origin of lithostratigraphic units at 10IH1308 are made on the basis of physical aspects, including the mineralogy, sorting, fabric, and geometry of deposits. By making an interpretation of the manner in which sediments were deposited at the site, *lithofacies* (i.e., “the rock record of any sedimentary environment” (Bates and Jackson 1984:298)) are defined and allow us to understand the environmental history of site formation. It appears that the deposits observed at 10IH1308 were formed under aeolian, alluvial, and fluvial depositional environments. By designating a genetic basis for each of the stratigraphic units, the geologic record of the Gill Gulch site can be related to the canyon-scale stratigraphic system provided by Davis (2001b), as seen in Table 1. The particular lithofacies included in this study

(e.g., *Qal4*) are defined elsewhere by Davis (2001b). Although this system may seem unnecessarily complicated, such an approach allows us to clearly identify stratigraphic units at the site level and relate them to the larger late Quaternary geologic record established for the LSRC. Such an approach is not only useful, but is critical for canyon-scale comparisons and syntheses of archaeological information.

Pedostratigraphy

Pedostratigraphic units are defined in site stratigraphy on the basis of observable soil development. Evidence for two soil horizons, designated as S1 and S2, was observed at 10IH1308 (Table 1; Figure 3). The stratigraphically lowest pedogenic horizon, S1, is identified by a marked increase in carbonate content, and greater consistency in LU 1. The second soil, S2, corresponds to the modern soil horizon, and has altered alluvial fan sediments of LU 6, LU 5, and LU 4 through slight darkening due to organic input, weak development of soil structure, and limited colloidal translocation between skeletal clasts. The S2 horizon appears better developed east of the erosional channel that separates excavation units A-B from C-D; this likely relates to a greater amount of surface stability on the eastern portion of the site during the

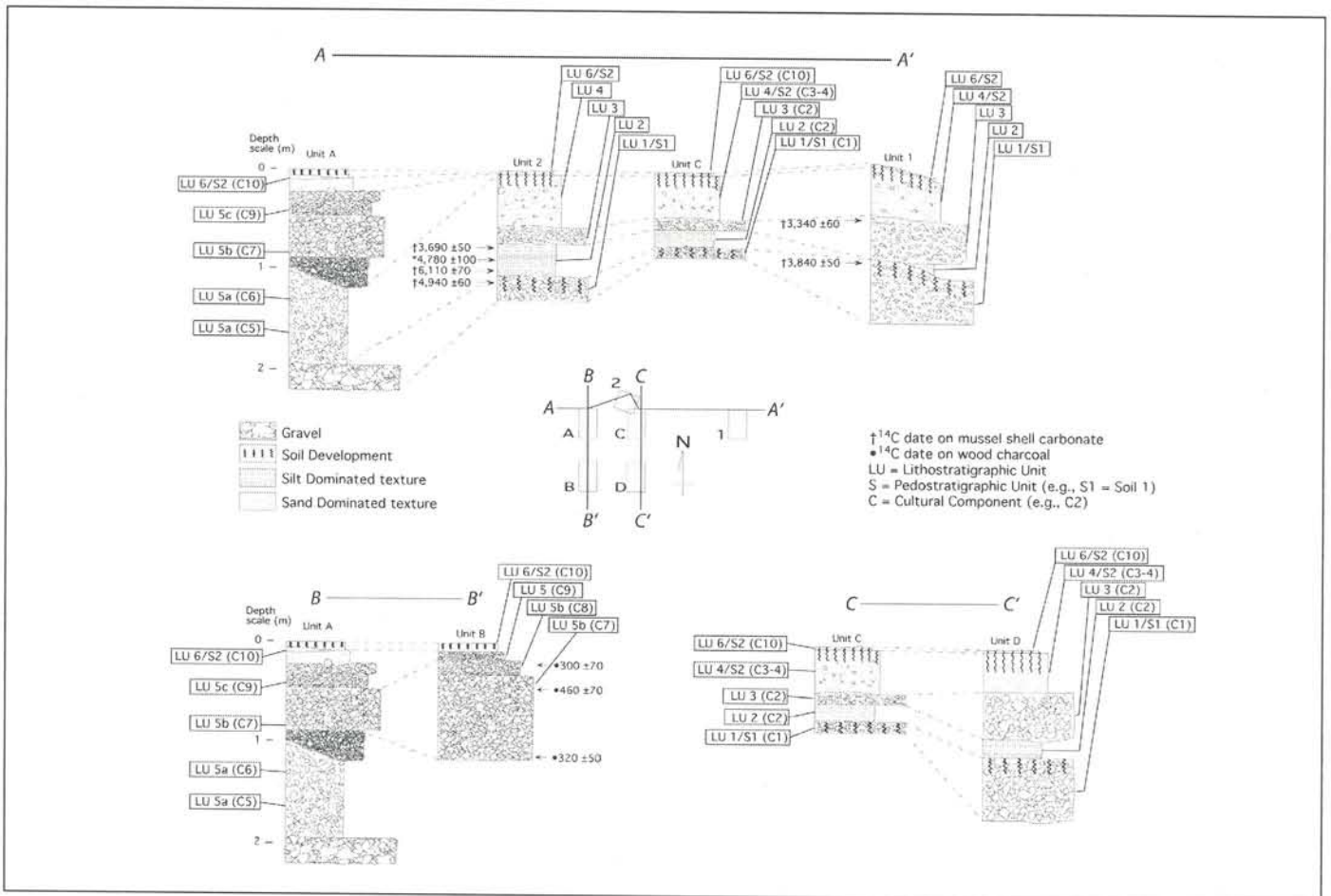


Figure 3. Correlation of stratigraphic profiles exposed in excavation units as seen along selected transects (e.g., A—A'). Correlations are indicated by dashed lines and are based on similarities in stratigraphic qualities and available dates. Mean texture of each stratigraphic unit is shown as a pattern fill (e.g., stippled patterns representing sand and silt-dominated deposits) and can be inferred by the relative width of the deposit's bar (i.e., wider deposit bars correspond to coarse-clastic gravel deposits and deposit bars with thinner widths reflect finer sediments).

TABLE 1.

Description of lithostratigraphic units and their associated lithofacies interpretations from the Gill Gulch site. Lithofacies designations (e.g., *Qa14*) follow Davis (2001b).

LU1 (*Qaf6*): LU1 is comprised of poorly sorted angular to subangular pebble to boulder gravels with a fine interstitial sediment component. This deposit is interpreted as originating from mass movement/debris flows associated with alluvial fan growth during wet periods of the year. Deposition probably occurred gradually, as narrow, elongate lobes of sediment-laden gravels were deposited on the surface of the fan.

LU2 (*Qa14*): Because of its fine silt-dominated texture, well sorted matrix, and elevation above the modern Salmon River Channel, LU2 sediments are interpreted to have formed during alluvial overbank flooding. This flood deposit represents a portion of the pre-2,000 B.P. lower Salmon River floodplain (Davis 2001b). In some stratigraphic profiles, concentrated lenses of Mazama tephra are associated with LU2 (tephra identification in Davis 2001b).

LU3 (*Qaf6*): LU3 appears as poorly sorted gravels with interstitial fine sediment and is interpreted as originating from mass movement/debris flows associated with alluvial fan growth during wet periods of the year. Deposition probably occurred gradually, emplacing thin lobes of sediment-laden gravels on the surface of the fan; the sum of which produced a net vertical aggradation of the landform.

LU4 (*Qae4/Qaf6*): LU4 is a poorly sorted angular to subangular gravelly sandy loam. A polygenetic origin is attributed to LU4, as aeolian deposition (*Qae4*) provided most of the sediment and occasional surficial runoff contributed gravels (*Qaf6*). Bioturbation would displace these gravel deposits somewhat, obscuring thin layers of gravels draped on aeolian sediment.

LU5 (*Qaf7*): LU5 appears as multiple deposits, closely similar to each other, and marks a return of alluvial fan gravel deposition, at an accelerated rate from previous periods. The presence of small moderately- to well-sorted gravel-filled channel features and wave-form structures in fine sediments suggests that action of moving water, oriented perpendicular to the Salmon River, contributed to its deposition. These channels may suggest increased runoff from the Gill Gulch tributary basin, and wetter canyon conditions overall. Alternatively, these alluvial features may be a constant aspect of alluvial fan deposition, encountered by chance in the profiles of excavation Units A and B. Based on its age, and appearance following a major period of alluvial floodplain and alluvial fan erosion, the post-2,000 B.P. alluvial fan deposits at the Gill Gulch site are subdivided from Davis' (2001b) original *Qaf6* designation, which included all alluvial fan deposits dating between 5,000 to 0 B.P.

LU6 (*Qaf7*): A thin cap of silty sediment seen across site, likely resulting from sheetwash from small surficial rivulets moving fines downslope during intense rains.

period in which S2 was formed. The absence of pedogenic development in LU 2 and LU 3 suggests that these sediments accumulated nearly continuously at the site.

Chronostratigraphy

As the name suggests, chronostratigraphic units deal with time. In the case of Gill Gulch site stratigraphy, relative (non-numerical) and absolute (numerical) dating methods were employed. The position of ¹⁴C dated samples make correlation possible between stratigraphic profiles in observed excavation units (Figure 4).

Radiocarbon Chronology. Six samples from Units 1, 2, and B were submitted for radiocarbon dating by the BLM in 1997, and three additional dates were obtained by the author in 2000. Throughout this paper, radiocarbon ages are reported in ¹⁴C years before present (B.P.) with 1-sigma errors (corresponding to a 66% confidence interval). All of the dates fall within the middle to late Holocene period, ranging between 6,110 ±70 B.P. (Tx-9274; mussel shell carbonate) and 300 ±70 B.P. (Beta-147093; wood charcoal) (Table 2). Radiocarbon dates from excavation Unit 2 show an apparent temporal reversal when organized in a stratigraphic sequence (Figure 3). The four radiocarbon dates from Unit 2 progress in a down-profile sequence from 3,690 ±50 B.P. (Tx-9272; mussel shell carbonate), 4,780 ±100 B.P.

(Beta-11657; mammal bone collagen), 6,110 ±70 B.P. (Tx-9274; mussel shell carbonate), to 4,940 ±60 B.P. (Tx-9275; mussel shell carbonate). In 1997, BLM archaeologists encountered water in the lower levels of their excavation units. Surface water, linked to unusually rainy El Niño-induced weather conditions, ran through Gill Gulch throughout the summer of 1997. Periodic saturation of the lower reaches of the site from rising groundwater under wet conditions like those seen in 1997 likely contaminated organic materials held in deeper deposits. During wet years, small streams flow in channels incised into the surface of the Gill Gulch alluvial fan and groundwater can be found in the gravels of LU 1. These conditions suggest that heightened discharge from bedrock aquifers may occur as recharge rates increase in response to greater runoff. Thus, old dissolved carbon in Gill Gulch aquifer water is the likely source of the discrepancy in the radiocarbon dates at 10IH1308. Although the bedrock in the immediate area is not carbonate-rich, a sample of dissolved carbon in water from a nearby shallow (<50 m) well returned a radiocarbon age in excess of 4,000 B.P., suggesting a relatively slow residence time for local aquifers (David Sisson, personal communication, 2005). Just as carbon that is sequestered in deep ocean currents can eventually become integrated into marine organisms, making them

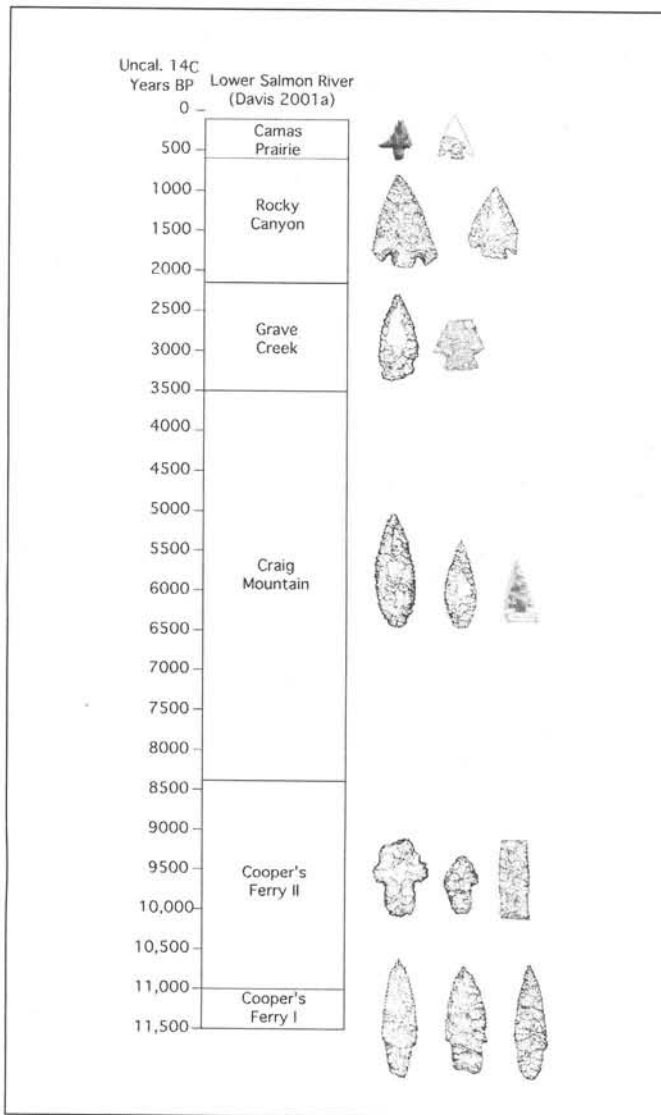


Figure 4. Representative projectile point types associated with culture history phases defined in the lower Salmon River canyon (after Davis 2001a).

appear older than they really are (i.e., the marine reservoir effect), slow rates of recharge in bedrock aquifers can introduce old carbon into sites near groundwater-fed streams. Because calcite and aragonite are susceptible to carbon exchange through dissolution and recrystallization with groundwater, shell dates have the potential for producing misleading radiocarbon ages. Above LU 1, radiocarbon dates appear to get younger in age closer to the surface of the site, which suggests, at face value, that no contamination of these deposits has occurred. On this basis, the dates of $6,110 \pm 70$ B.P. and $4,940 \pm 60$ B.P. are thought to be contaminated, and are therefore rejected.

Three radiocarbon dates on wood charcoal are available from Unit B, and show a temporal reversal in their stratigraphic order (Table 2). This discrepancy between the dates of 320 ± 50 B.P. (Beta-147095; wood charcoal) and 460 ± 70 B.P. (Beta-147094; wood charcoal) could result from burning wood of different ages. The inhabitants of 10IH1308 may have gathered and burned driftwood that lay on the banks of the river for several decades. Ultimately, the 2-sigma error shows overlap between the radiocarbon ages suggesting they both fall within the same age range and the vertical discontinuity of numerical ages observed here is more apparent than real.

Tephrochronology. Volcanic tephra mixed with the silty sediment of LU 2 is seen in Unit 2 (Dickerson 1997) and in Unit D. Electron microprobe analyses on this tephra revealed an elemental composition that best matched Mazama O (Davis 2001b). This tephra is stratigraphically bracketed above by a date of $3,960 \pm 50$ B.P. and below by a date of $4,780 \pm 100$ B.P. The position of radiocarbon dates younger than the 6,850 B.P. eruption date of Mazama O tephra (Bacon 1983), both above and below LU 2, suggests that the tephra was redeposited at the site. Since alluvial fans are zones in which sediments eroded and transported from higher elevation are stored,

TABLE 2.

Radiocarbon dates from 10IH1308. Unit refers to excavation unit sample was collected from. Provenience includes catalog date and/or excavation level sample originated from. Sample # designates laboratory sample number (Beta = Beta Analytic; Tx = University of Texas, Austin). All dates reported in uncalibrated ^{14}C years before present (B.P.), with one-sigma errors (e.g., ± 70).

Unit	Provenience	Method	Sample #	Material	Uncal. ^{14}C age
B	1308-555, Level 2	Radiometric	Beta-147093	wood charcoal	300 ± 70 B.P.
B	1308-1483, Level 9	Radiometric	Beta-147095	wood charcoal	320 ± 50 B.P.
B	1308-832, Level 4	Radiometric	Beta-147094	wood charcoal	460 ± 70 B.P.
1	1308-32, Level 5	Radiometric	Tx-9271	mussel shell	$3,340 \pm 60$ B.P.
2	1308-231, Level 9	Radiometric	Tx-9272	mussel shell	$3,690 \pm 50$ B.P.
1	Level 9	Radiometric	Tx-9273	mussel shell	$3,840 \pm 50$ B.P.
2	1308-280, Level 13	Radiometric	Tx-9275	mussel shell	$4,940 \pm 60$ B.P.
2	1308-363, Level 10	AMS	Beta-11657	bone collagen	$4,780 \pm 100$ B.P.
2	1308-237, Level 10	Radiometric	Tx-9274	mussel shell	$6,110 \pm 70$ B.P.

this type of temporal discontinuity through reworking of sediment should come as no surprise.

Allostratigraphy

Allostratigraphic frameworks view site stratigraphy from the perspective of geologic stability and instability. The nature of stratigraphic boundaries between lithostratigraphic units are defined as either conformable or unconformable on the basis of whether they represent periods of continued deposition, surficial stability, or erosion (Waters 1992:68-73). Because they reflect periods of surficial stability (e.g., nondeposition and soil development) or surficial instability (i.e., erosion), unconformable stratigraphic boundaries show a break in time in a stratigraphic sequence and provide boundaries for allostratigraphic units (NACOSN 1983).

Using an allostratigraphic perspective, we can begin to understand the sequence of site formation at Gill Gulch. A lateral stratigraphic unconformity, as seen in the sedimentary structure and age of LU 5, is inferred to exist between Units C-D and A-B. An allostratigraphic boundary can be placed at the contact between LU 5 and the older deposits that lie beneath it and to the east at 10IH1308. This boundary marks the transition from a period of major erosion to the resumption of deposition on the Gill Gulch fan. Because the history of Gill Gulch site formation includes a significant period of erosion followed by fan aggradation, a lateral discontinuity in the chronology of sedimentation and archaeological components will be present at 10IH1308. Simplified, allostratigraphy shows us that the archaeological record is not completely contained in the vertical sequence of any one place but can only be seen by laterally correlating separate vertical sequences across the landform.

Archaeological Stratigraphy

Archaeological components were encountered in each of the lithostratigraphic units. For the purposes of this paper, discussion here is limited to the distribution of temporally distinct artifact types and cultural features in site stratigraphy. With few exceptions, projectile point styles discovered at the Gill Gulch site, summarized in Figure 4, can be attributed to culture history phases defined by Davis (2001a). In discussion and figures to follow, cultural components may be presented in an abbreviated form (e.g., Component 3 shown as C3).

Component 1. Projectile points associated with Component 1 include side-notched and corner-notched varieties that are typical of the Craig Mountain and Grave Creek phases, which date between 8,400-3,500 B.P. and 3,500-2,100 B.P., respectively. One point is similar to the Elko corner-notched form (Jennings 1989:Figure 4.16) and is atypical of LSRC phases. Component 1 is associated with LU 1 (*Qaf6*) and dates immediately before 4,780 ±100 B.P.

Component 2. Includes side-notched and corner-removed varieties typical of the Craig Mountain and Grave Creek phases, and a small stemmed and basally notched obsidian point not typically seen in the canyon. Component 2 is associated with LU 2 (*Qa14*) and LU 3

(*Qaf6*), and dates between 4,780 ±100 and 3,960 ±50 B.P.

Components 3 and 4. Components 3 and 4 are difficult to separate completely since they are both contained within LU 4 (*Qae4/Qaf6*) in Units C and D. Projectile points associated with Component 3 include side-notched and corner-notched varieties typical of that seen in the Grave Creek phase, which dates between 3,500-2,100 B.P. Component 4 produced side-notched and corner-notched projectile point varieties attributed to the Grave Creek phase (3,500-2,100 B.P.) and the Rocky Canyon phase (2,100-600 B.P.). Component 4 also includes a squat, stemmed specimen not typically seen in the canyon, that may be a Tucannon contracting stem point (cf. Leonhardy and Rice 1970). Components 3 and 4 are closely overlapping occupations with a continued accumulation of cultural materials after 3,340 ±60 B.P. but before 2,000 B.P.

Components 5 and 6. Components 5 and 6 were encountered only in the south 1 x 2 of Unit A. Projectile points associated with Component 5 include side-notched varieties that would not be unexpected in Grave Creek phase (3,500-2,100 B.P.) assemblages but could also occur later in time. Components 5 and 6 are associated with LU5 (*Qaf7*) and are thought to date between ca. 2,000 B.P. and 320 B.P.

Components 7 and 8. Projectile points are typical of side-notched and corner-notched varieties found in Grave Creek and Rocky Canyon phase (2,100-600 B.P.) assemblages. In general, Components 7 and 8 are associated with LU 5 (*Qaf7*) and are thought to date between ca. 2,000 B.P. and 320 B.P. Component 8 includes abundant fragments of charcoal dispersed through alluvial fan sediments, a charred wooden post found *in situ*, and an unlined oxidized hearth stain; all of which project a spatial pattern interpreted to represent the burned remains of a semi-subterranean pit house structure dated to 460 ±70 B.P. (Beta-147094; wood charcoal).

Components 9 and 10. These components include a complete Camas Prairie point and a single fragmentary projectile point with concave sides similar to types seen in the Camas Prairie phase (600-150 B.P.). A thin (1 cm thick) layer of compact sediment with a small scatter of associated artifacts and faunal materials (mostly mussel shell) corresponds with Component 9, and is thought to represent an occupational surface within an above-ground tent or mat lodge structure. A charcoal sample from Component 9 returned a ¹⁴C age of 300 ±70 B.P. Component 10 appears in the uppermost deposit of the Gill Gulch site (LU 6 [*Qaf7*]) and post-dates 300 B.P.

A MODEL OF SITE FORMATION

Prior to 5,000 B.P.

Extensive deposits of alluvial fan gravels were present prior to 5,000 B.P., forming a foundation for later periods of deposition (Figure 5). A period of surficial stability is suggested during this time, represented by the development of the S1 soil horizon. Because of the lower limiting age of the LU 2 deposit (at 4,780 ±100 B.P.), this period of soil development likely represents an equivalent to the American Bar Soil, which developed in the LSRC

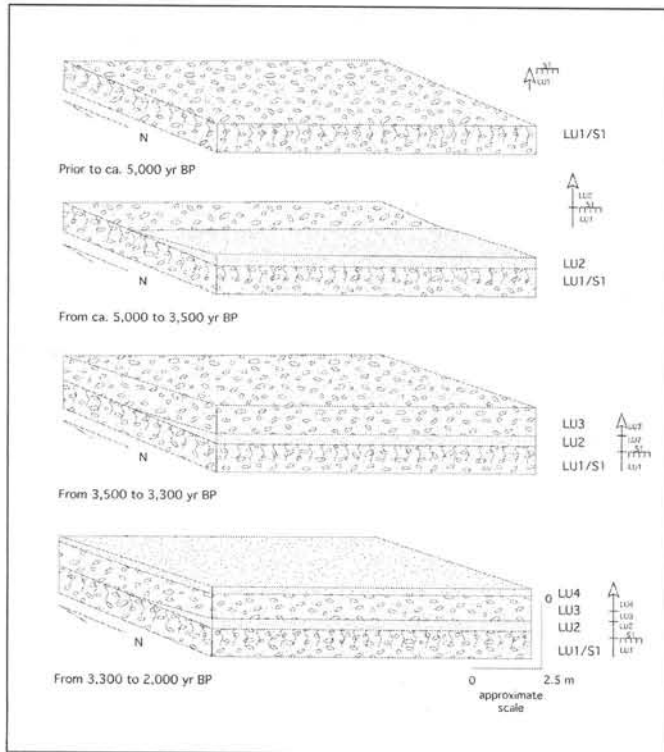


Figure 5. Block diagrams showing the inferred evolution of the Gill Gulch fan in the area of 10IH1308 between ca. 5,000 and 2,000 B.P.

between ca. 6,000 and 7,000 B.P. (Davis 2001b). The Gill Gulch fan probably provided a stable landform for prehistoric human occupation during this time period.

From ca. 5,000 to ca. 3,500 B.P.

The presence of silty LU 2 sediments marks a change to alluvial deposition at the site (Figure 5). During much of the Holocene, the lower Salmon River built a low-energy floodplain between Hammer Creek and American Bar, evidenced by the widespread deposition of fine, brownish-colored, silty-textured sediments (Davis 2001b).

From ca. 3,500 to 3,300 B.P.

The deposition of LU 3 alluvial fan gravels caps the aggrading floodplain sediments of LU 2 in the area of Units A-D (Figure 5). This shift in depositional energy is likely related to a shift toward increased precipitation in the LSRC after 4,000 B.P. (Davis and Muehlenbachs 2001; Davis 2001b). Clastic materials that accumulated in upper reaches of Gill Gulch were flushed out during this period, causing the Gill Gulch fan to aggrade rapidly.

From 3,300 to 2,000 B.P.

By ca. 3,300 B.P., precipitation rates rapidly shift back to modern conditions (Davis and Muehlenbachs 2001) and reach values drier than today by 3,000 B.P. During this period, the Gill Gulch fan is covered by a thin layer of sandy loam (LU4), which on the basis of its grain size and sorting, is interpreted as aeolian in origin (Figure 5). These aeolian sediments were blown in from the nearby alluvial floodplain during the dry season. High energy,

low duration rainfall events distributed gravels and sediment across the fan surface.

At 2,000 B.P.

Closely corresponding to a marked increase in canyon precipitation (Davis and Muehlenbachs 2001), the Salmon River cut through its broad floodplain at ca. 2,000 B.P. (Davis 2001b) (Figure 6). The vertical displacement of the river channel, coupled with increased discharge of the tributary stream under wetter conditions, induced erosion of the Gill Gulch fan and removed large portions of LU 1-LU 4 and any archaeological materials they may have held.

From 2,000 to ca. 300 B.P.

During the 1,700 ¹⁴C years following the period of late Holocene incision, the Gill Gulch fan aggraded once again under a precipitation regime slightly wetter than today (Davis and Muehlenbachs 2001), depositing LU 5 (Figure 6). The presence of small cut and fill features in LU 5 suggest that deposition was not entirely dominated by debris flow processes. In fact, the deposition of LU 5 likely included a small stream that meandered back and forth across the fan during the wetter seasons. Pedogenic development of the S2 horizon in stabilized LU 4 deposits is seen at this time as well.

Last 300 B.P.

Drier conditions from the previous 1,700 B.P. (Davis and Muehlenbachs 2001) are met with a return of aeolian deposition at the Gill Gulch site, as seen in the addition of LU 6 sediments (Figure 6). Road building activities during the 20th century altered the drainage pattern of Gill Gulch, which seems to have caused a small stream to incise into the surface of 10IH1308 near the edge of the LU 5 gravels.

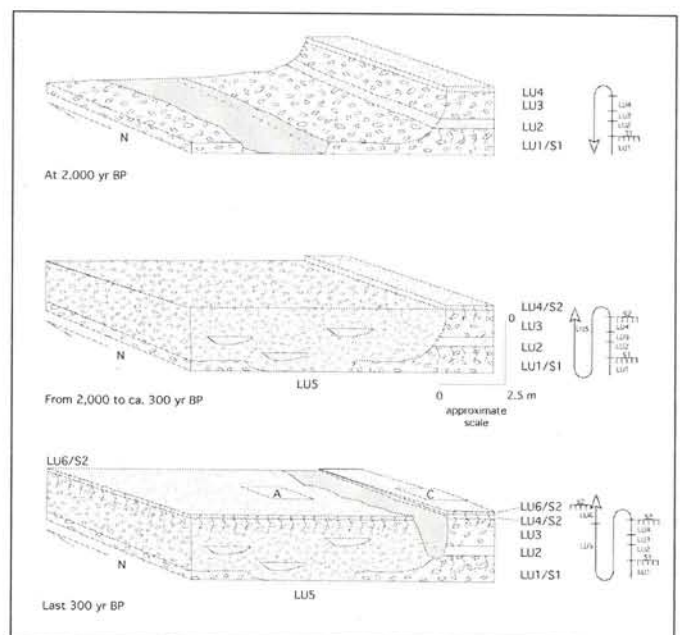


Figure 6. Block diagrams showing the inferred evolution of the Gill Gulch fan in the area of 10IH1308 between 2,000 B.P. and the last 300 B.P.

DISCUSSION AND CONCLUSIONS

Cultural materials, spanning nearly 5,000 ¹⁴C years, are found in all lithostratigraphic units encountered during excavations at the Gill Gulch site. From a geologic perspective, the Gill Gulch site has experienced considerable change over this time period, involving episodes of alluvial fan, alluvial floodplain, and aeolian sedimentation, interrupted by large-scale erosion. This dynamic geologic history has both helped to preserve a long sequence of cultural occupation at the site and contributed to its destruction.

Although this current investigation deals with only a small part of a much larger site, we can draw several important lessons from this work regarding archaeological investigation of sites in alluvial fan contexts. First, given the geomorphic nature of alluvial fans, archaeologists must not assume that the vertical continuity of stratigraphic sequences will be maintained across the site, even at a horizontal scale of tens of meters. Second, because the source of coarse clastic sediment (e.g., gravels) in an alluvial fan is typically constant through time, and is usually derived from the bedrock of its tributary basin, it is difficult to order and correlate gravel-dominated geologic units without adequate chronometric control. Thus, interpreting archaeological records from alluvial fan sites can be extremely challenging in the absence of post-depositional soils or weathering horizons, without more than a few radiocarbon dates.

This lesson is particularly important in the case of tephtras; more likely than not, tephtras will be redeposited within alluvial fan deposits, and provide a false temporal marker. The habit of assigning age to cultural components relative to their position "above Mazama" or "below Mazama" is a particularly dangerous, if not meaningless, practice in alluvial fan sites without adequate chronometric dating. In the case of the Gill Gulch site, "below Mazama" components are not older than the 6,850 B.P. eruption age of the Mazama Set O tephtra (Bacon 1983). Instead, site chronostratigraphy shows that cultural materials found below Mazama tephtra date younger than 4,780 B.P. Where volcanic tephtras form secondary deposits in site stratigraphy, any archaeological materials they may contain are most likely redeposited as well. Just as the redeposition of a volcanic tephtra produces a false chronostratigraphic marker, the erosion and redeposition of temporally sensitive artifacts in alluvial fan sites may signal a temporal inversion in site stratigraphy. In this scenario, artifacts redeposited along with a volcanic tephtra may be contemporaneous to, predate, or post-date the tephtra, depending on the timing and extent of the erosional episode. Because the Mazama tephtra layer at the Gill Gulch site contains a few pieces of debitage, but no typologically distinct artifacts, the presence of associated redeposited archaeological components cannot be proven, only suspected, and their specific temporal context cannot be clearly assessed.

Although alluvial fan deposition and erosion can be driven by specific environmental conditions or events, we must exercise caution when attempting to generate

paleoenvironmental or paleoclimatic records from alluvial fan depositional sequences alone. While alluvial fans undoubtedly respond to some degree of local- and regional-scale climatic and environmental forces, the response may not be consistently related to a single factor. For example, while rates of alluvial discharge may be reduced during periods of increased aridity, the corresponding reduction in vegetation cover throughout a tributary alluvial basin may lead to significant periods of erosion and fan sedimentation during low duration, high intensity rainfall events. Conversely, large quantities of colluvium may be stored in a tributary basin during arid periods, only to be flushed out and redeposited as alluvial fan gravels during a shift to wetter conditions and heightened alluvial discharge.

Since alluvial fans are often constructed as a sequence of overlapping sedimentary lobes, with depositional phases commonly punctuated by periods of significant erosion, archaeologists must approach excavation of sites contained in fans differently than other types of sites. To understand a complete record of human habitation on an alluvial fan, multiple vertical sequences should be assembled and compared laterally. With adequate absolute age control, which is determined by the complexity of the site, a synthetic understanding of an alluvial fan site is possible. However, in the absence of the kind of approach presented in this paper, alluvial fan sites are not only extremely difficult to understand, they hold the potential for inducing misleading and erroneous interpretations of the archaeological record.

Figure 7 shows two interpretative scenarios for the Gill Gulch site's cultural chronology. When the stratigraphy of the Gill Gulch site is interpreted in a top-down manner, with no attention paid to the lateral aspects of deposition and erosion, we can arrive at a different interpretation of culture history. In the first scenario (Figure 7a), the site is assumed to have formed through synchronous addition of relatively equal depositional layers across the site, which would result in a horizontally and vertically consistent archaeological sequence. At face value, the undifferentiated gravel deposits that were so common in the site stratigraphy offer few clues that this first interpretative scenario might be incorrect. When we consider the typologically-distinct projectile points recovered in the site stratigraphy, the "layer cake" stratigraphy assumed in the first scenario produces an exaggerated degree of overlap between cultural phases. Under this scenario, the lower portion of the site appears to include a diachronous period between Craig Mountain and Grave Creek phase components; this transition is not necessarily unusual, although the absence of Craig Mountain phase artifacts at the bottom of Unit A is problematic. However, in the middle of the stratigraphic sequence, Craig Mountain, Grave Creek, and Rocky Canyon phase points can be found in the same layer. This situation brings up the question of whether the layer represents a time-averaged surface, with little geologic deposition and a palimpsest of multiple cultural phases, or whether the separation between the three phases is imaginary and not correct, as suggested by Davis

a		
Unit A	Unit 1	Unit C
C10 (Camas Prairie)	C10 (Camas Prairie)	C10 (Camas Prairie)
C9 (Camas Prairie)	C4 (Grave Creek/ Rocky Canyon)	C4 (Grave Creek/ Rocky Canyon)
C8 (Grave Creek/ Rocky Canyon)	C3 (Craig Mountain/ Grave Creek)	C3 (Craig Mountain/ Grave Creek)
C7 (Grave Creek/ Rocky Canyon)	C2 (Craig Mountain/ Grave Creek)	C2 (Craig Mountain/ Grave Creek)
C6 (Grave Creek)	C1 (Craig Mountain/ Grave Creek)	C1 (Craig Mountain/ Grave Creek)
C5 (Grave Creek)	unexcavated	unexcavated

b		
Unit A	Unit 1	Unit C
C10 (Camas Prairie)	C10 (Camas Prairie)	C10 (Camas Prairie)
C9 (Camas Prairie)	C4 (Grave Creek/ Rocky Canyon)	C4 (Grave Creek/ Rocky Canyon)
C8 (Grave Creek/ Rocky Canyon)	C3 (Craig Mountain/ Grave Creek)	C3 (Craig Mountain/ Grave Creek)
C7 (Grave Creek/ Rocky Canyon)	C2 (Craig Mountain/ Grave Creek)	C2 (Craig Mountain/ Grave Creek)
C6 (Grave Creek)	C1 (Craig Mountain/ Grave Creek)	C1 (Craig Mountain/ Grave Creek)
C5 (Grave Creek)	unexcavated	unexcavated

Figure 7. Two scenarios of cultural stratigraphy at the Gill Gulch site. The first scenario (a) assumes a horizontally-consistent layering sequence in which cultural components (e.g., C10) and the typologically-distinct artifacts they contain are easily correlated across the site. The second scenario (b) represents the actual interpretation of the site's archaeological chronology, based on an understanding of its geoarchaeological context.

(2001a). Of course, recognizing that the site's stratigraphy is more complex and that significant temporal variability exists at both horizontal and vertical scales between excavation units produces an entirely different archaeological interpretation (Figure 7b). Without the detailed geoarchaeological analysis of the site revealing the complex history of deposition and erosion, our interpretation of the site record, and more importantly LSRC prehistory, would be quite different. The point made here is that without a thorough understanding of the depositional environment of the Gill Gulch site alternate and misleading interpretations are possible. By combining geoarchaeological and archaeological perspectives it was possible to arrive at a better interpretation of the cultural record held in the Gill Gulch site.

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SHORT CONTRIBUTIONS

BOOK REVIEW

THE THEORY AND PRACTICE OF ARCHAEOLOGY: A WORKBOOK, THIRD EDITION

By Thomas C. Patterson, Pearson Education, Inc., Upper Saddle River, New Jersey, 2005.
173 pp., softcover, \$28.00, references, no index.

Reviewed by Mark C. Münch

The volume under review uses a problem-oriented approach to show its readers how to think like an archaeologist and in the process demystify what archaeologists actually do. *The Theory and Practice of Archaeology: A Workbook*, now in its the third edition (1983, 1994), moves away from typical issues presented in most 'Introduction to Archaeology' textbooks. Instead of detailing archaeological survey methods, test excavation strategies, or data recovery plans, this book presents a more detailed analysis of interpretive and explanatory processes that archaeologists use when studying peoples of the past.

Following a preface, a section detailing suggestions for use of the book by teachers, and a brief Introduction, the workbook is organized into two sections – "The Problems" and a "Discussion of the Problems". A total of twelve problems (theoretical issues) are addressed and each is divided into two parts: (1) a brief introduction to the topic and a description of the techniques used to answer questions regarding the topic, and (2) a presentation of the data and the questions themselves. After the presentation of the problems, there is a discussion of how one archaeologist, the author, went about answering the questions.

Patterson uses data from several regionally simulated archaeological sites/assemblages to address a range of issues presented in the book. The first problem deals with how to establish a temporal sequence from excavated archaeological evidence. The basics of stratigraphy, the law of superposition, and relative and absolute dating are addressed. The second problem is seriation. Here, Patterson addresses ordering archaeological evidence by stylistic differences. Because the data are from the same archaeological site, the reader is challenged to interpret how the seriation ordering established corresponds to the cultural sequence revealed by the stratigraphic excavation in the first problem. The third problem involves constructing a regional chronology.

Contemporary archaeological assemblages from the same region are examined to help identify what constitutes the development of a regional chronology. Once again, the reader is challenged to determine what relationships are present between the data sites presented and the excavated site described in the first problem.

Patterson's fourth problem deals with modes of production, divisions of labor, and social reproduction. Among other things, the reader is challenged to identify how the technical divisions of labor are represented at different sites, identify any evidence for gender-linked craft specialization, and interpret what implications might the activities at these sites have for the organization of the community. The fifth and sixth problems address the operating conditions of time and place as they are regulated and mediated by labor, and the construction and transformation of regional landscapes. Patterson addresses seasonality, resource availability, and site specialization and examines the ways in which archaeologists understand the relationship between the members of a historically specific society and their environment.

The seventh problem addresses social divisions of labor and class structure while Patterson's eighth problem specifically addresses state formation, conquest abroad and repression at home. A total of six sites representing two distinct temporal phases are examined. The ninth problem addresses the relationships between state societies and frontier societies while the tenth problem addresses state formation and the reorganization of social production and reproduction. The reader uses data presented in Problems 7, 8, and 9 to examine with these issues. Next, Patterson discusses the social construction of gender, ethnicity, and race. Using data from Problems 9 & 10, the reader is challenged to, among other things, identify when and under what circumstances class structures appeared and how gender relations transformed in circumstances shaped by class and state formation. Finally, Patterson addresses class struggle and resistance.

Though Patterson's discussion is broad in its consideration of theoretical and methodical issues it is not comprehensive. The work does, however, provide a useful means of introducing students to the nature of archaeological inquiry. The major problem with the book is its organization, which requires that one read the problems in the first part of the book, and then move to the back to read the discussion of the problem; only to move back to the front for the next problem. The book would be somewhat easier to use if the two sections for each problem were presented together. On the other hand, the book is

well illustrated with numerous figures that detail much of the simulated data.

The target audience for this book, college level students, will find benefit in its information. In addition, as Patterson points out in his suggestions for teachers, the book is relevant in courses and contexts other than archaeology. Students learning about cultural anthropology, history, sociology, women's studies, and political economy may find this a useful companion tool in helping to better understand these disciplines in a historical context.



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