#59

THE LATE QUATERNARY ALLUVIAL CHRONOLOGY OF THE MIDDLE FORK OF THE SALMON RIVER: FIRST APPROXIMATION

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Introduction

Between 14 June 1982 and 15 July 1982 a small group of students enrolled in a University of Idaho Field School conducted field research on the quaternary geochronology of the Middle Fork of the Salmon River in the River of No Return Wilderness Area. The objective of the field school was to train students in field methods acquiring data relevant to a specific problem. The problem was to determine landforms and the chronology of landforms utilized by prehistoric residents (and even contemporary residents). Given the limited data about prehistory in the River of No Return Wilderness and the limited funding available for research, this geoarchaeological approach to the physical environment was a reasonable program for both acquiring useful information and training students.

The research universe was the canyon of the Middle Fork between Loon Creek and Big Creek and the lower canyons of Camas Creek and Big Creek (Fig. 1). The problem was to define the terrace system and to try to discover relationships between this aspect of the physical environment and the occurrence of archaeological sites. The methodology was simple in principal but sometimes difficult in practice. The number of constructional terraces

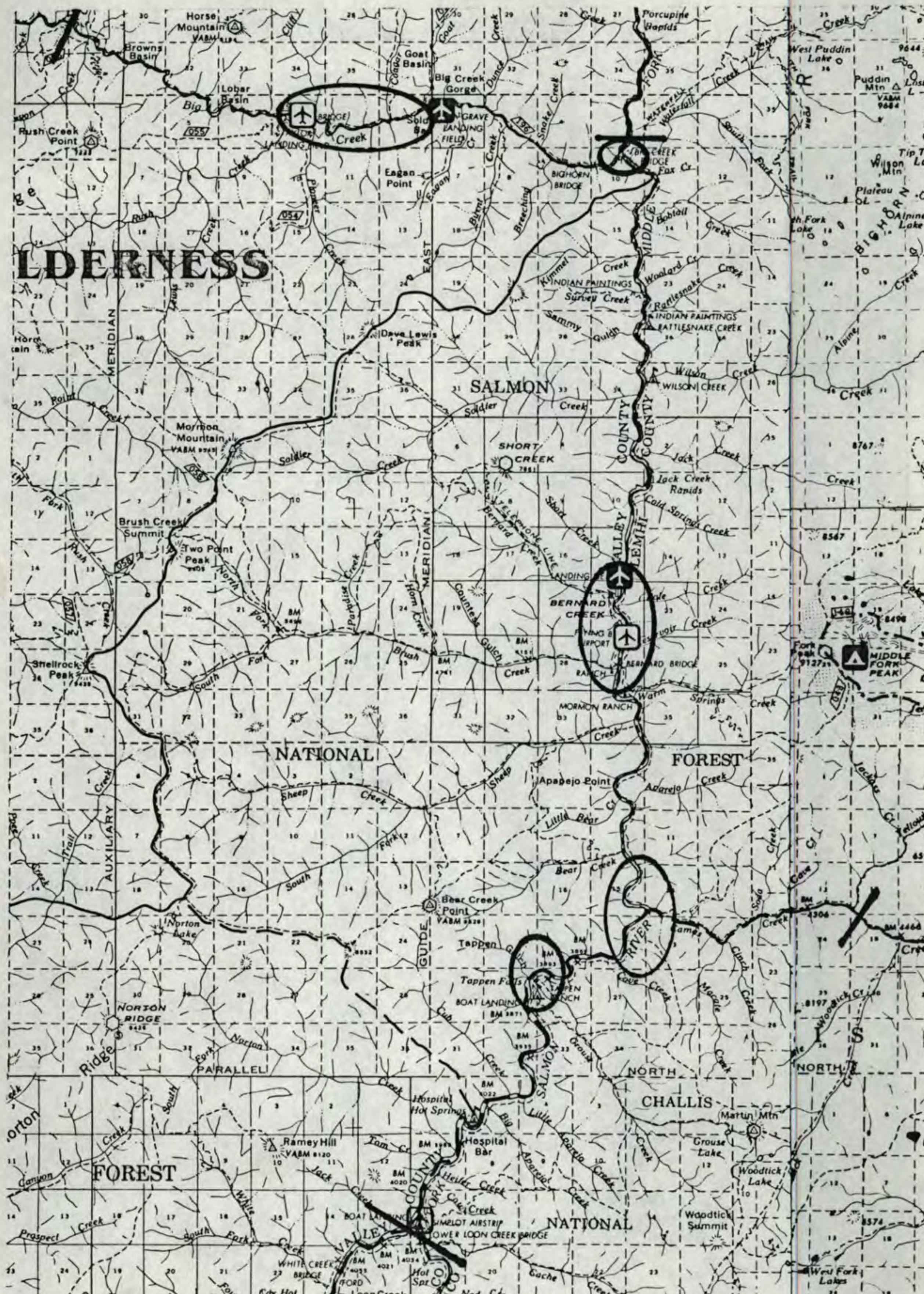

Fig. 1. Study area in the River of No Return Wilderness Area. Lines at right angles to the drainage mark the limits of reconnaissance; ovals denote study localities.

at each locality was determined by ground inspection, air photo interpretation, and profile measurement. Then, using relative terrace sequence and relative elevations, localities were correlated. From this correlation comes the interpretation presented herein. The interpretation is preliminary. The outline presented seems reasonable enough, but it is incomplete and assumptions about relative chronologies and correlations of depositional episodes are very tenuous. Still, one must start somewhere, and this interpretation is offered as a first approximation of the late Quaternary geochronology of the Middle Fork of the Salmon River.

The Terrace Sequence

Five localities were studied and measured. The Camas Creek Locality was the most intensively studied and is the key locality (Fig. 2). The other localities were Tappan Ranch, the Flying B Ranch, Lower Big Creek, and an unnamed locality below the Big Creek-Middle Fork confluence. The entire suite of terraces and terrace remnants was not found at any one locality, although Tappan Ranch has a nearly complete sequence.

Terraces or terrace remnants representing aggredation of the Middle Fork and two major tributaries were recorded at elevations ranging from 1 m to 118 m above 1982 high water. There are higher surfaces not measured directly. At each locality and between localities, elevations of each surface, determined at the break in slope at the top of the face, fell within narrow ranges of elevation. With three exceptions surfaces in the same elevational range were found at two or more localities.

The criteria for assuming contemporaneity on the basis of absolute elevation had to be somewhat flexible. Natural surfaces are not perfectly plane, laid out with a transit and graded with a leveler. Alluvial aggredational surfaces normally increase in elevation from upstream to

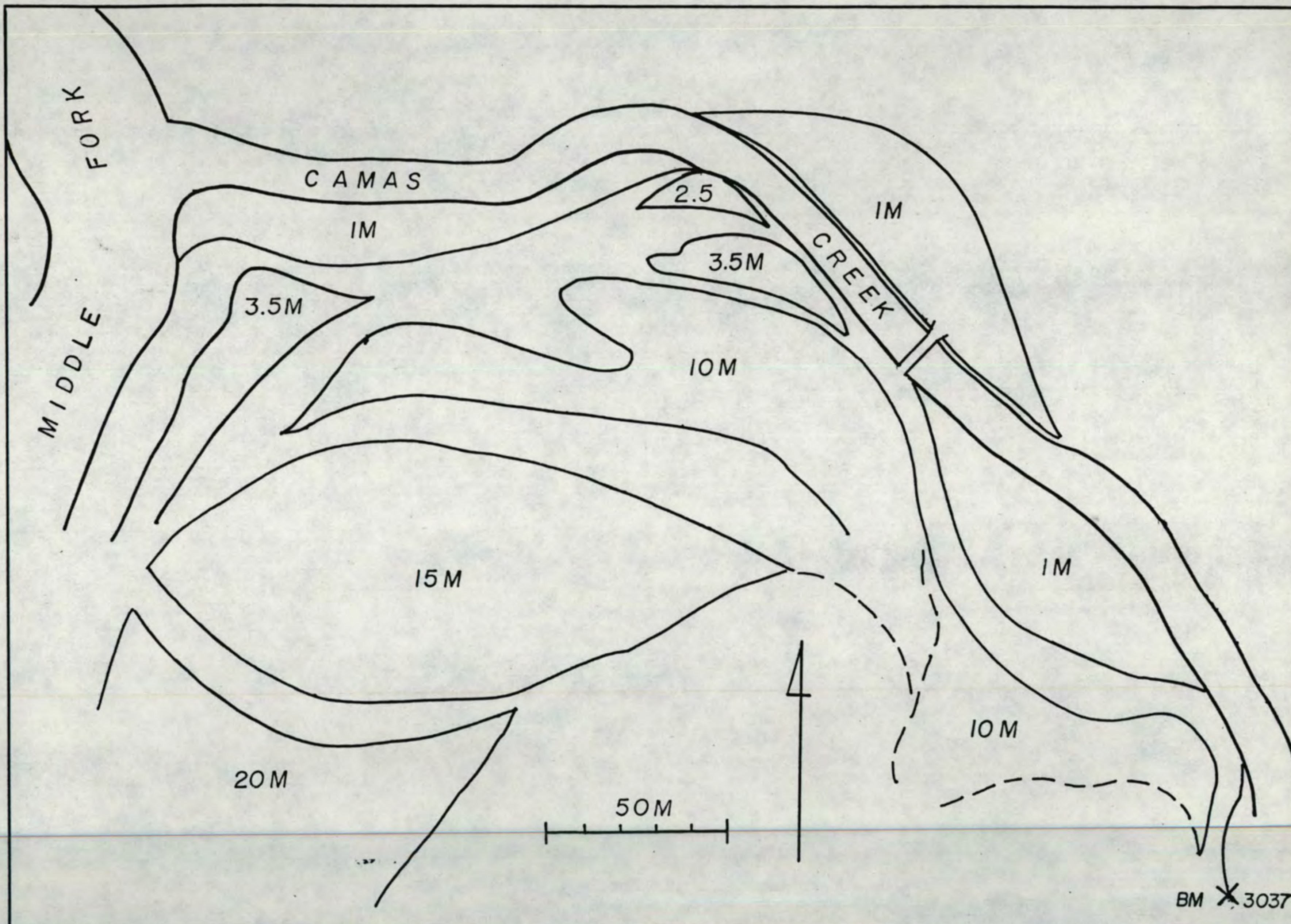

Fig. 2. Measured sketch map of the confluence of the Middle Fork of the Salmon River and Camas Creek showing positions of terraces at 20 m and below. Ovals indicate positions of small terrace remnants.

downstream and from outside (the bank) to inside. They may also be higher in the center than on the periphery. Therefore, absolute elevation alone is not a sufficient basis for correlation. All elevations recorded generally fall into consistent clusters which range from a few centimeters to as much as 4 m. In cases where clusters are closely spaced, as the instance of the 2.5 and 3.5 m clusters, they were separated as distinct terraces because surfaces at both elevations were found adjacent to one another in two different localities. In another situation, the surfaces found at 5 m on Big Creek may not be a distinctive terrace because its distribution and that of the 3.5 m surface are mutually exclusive. Both were found with the 1.5 m surface but never with each other. The 5 m surface could well represent the same aggredational event as the 3.5 m surface. In all other instances, surfaces found within the same cluster are assumed to represent the same geologic event and are considered contemporaneous. This assumption will have to be challenged later.

Table 1 summarizes the measurements. Each cluster is delinated and the number of instances a surface within that range was recorded is given. The ordinal sequence for the Middle Fork, Camas Creek and Big Creek is given. Individual terraces are designated by an approximate elevation rather than ordinal position, because ordinal position could well change with further information. By this interpretation 11 terraces are presently recognized. Three possibly distinct terraces are not presently included. One is a 37 m surface on the west bank of the Middle Fork opposite the mouth of Camas Creek. This elevation is unique and may represent an erosional surface. Other terraces in this particular place pair with terraces on the east side of the River. The second not included in not really a terrace, but a remnant of alluvial gravel found at 80 m in the Camas Creek Canyon. It too is a unique occurrence. The final surface not presently included is Soldier

TABLE 1

Summary of Middle Fork terrace data*

Terrace Designation (m)	Ordinal Sequence BC	CC	MF	Recorded Elevation Range (m)	Number of Occurrences Recorded BC	CC	MF
120			11	118			1
60			10	61 to 66			3
50			9	50 to 54			3
None			8	37			1
30			7	27 to 33			4
20	5		6	20 to 23			5
15		5	5	14 to 16		1	3
10	4	4	4	7 to 11	2	1	1
3.5	3	3	3	3.5 to 5	5	2	3
2.5	2	2	2	2.3 to 2.7	4	2	1
1	1	1	1	0.8 to 1.5	6	3	4

*Does not include Soldier Bar on Big Creek or a gravel remnant at 80 m on Camas Creek.
BC - Big Creek Locality, CC - Camas Creek Locality, MF - Middle Fork Localities.

Bar on Big Creek. One unique measurement is included. At Tappan Ranch is a prominent terrace remnant at 120 m. So, the number of terraces given in this interpretation is minimal and will surely be altered with continuing work.

The terraces at 1 m, 2.5 m, 3.5 m, and 10 m were encountered throughout the study area. These occur as the constructional surfaces of point bars. The 1 m terrace is particularly prominent at Tappan Ranch and at the Flying B Ranch. It is extensively distributed along Big Creek. The 2.5 m terrace was recorded only at the Camas Creek locality and on Big Creek. It occurs only as two small remnants near the mouth of the creek. The 3.5 m terrace was also documented only at Camas Creek and on Big Creek, and in both places appears physiographically distinct from the 2.5 m terrace. At Tappan Ranch a small terrace occurs at 4 m and there is a small terrace remnant at 4 m at the confluence of Camas Creek and the Middle Fork. Because no juxtaposition between the Middle Fork Sequence and the Tributary sequences were found, the 4 m surfaces are considered contemporary with the 3.5 m surfaces. Terraces at 5 m occur only on Big Creek and may well have the same ordinal position as the 3.5 m (and 4 m) surface. The correlations of surfaces at 3.5 m, 4 m, and 5 m is tenuous at best and is made on the basis of negative evidence - none were found juxtaposed.

The 10 m terrace was encountered once on Camas Creek, once on the Middle Fork, and once on Big Creek. On Camas Creek and on the Middle Fork this was a prominent surface. On Big Creek it was a small remnant.

Terraces at 15 m were recorded at Tappan Ranch, on Camas Creek, and across the Middle Fork from Camas Creek. Terraces at 20 m are particularly prominent on the Middle Fork from Tappan Ranch to just down stream from Camas Creek. A remnant at 20 m was recorded on Big Creek.

Thirty meter terraces are also prominent along the Middle Fork but were not recorded on the tributaries. It was recorded at all localities on the Middle Fork. At the locality below Big Creek it is a bedrock terrace overlain with gravel.

There are three prominent occurrences of the 50 m terrace on the Middle Fork. One is at Tappan Ranch, one opposite the mouth of Camas Creek, and the third, a bedrock terrace covered with gravel, below Waterfall Creek.

One of the most prominent geomorphic features in the entire Middle Fork Canyon is the pair of terraces at 60 m in the Flying B locality. Their size and integrity are not matched anywhere else in the study area but their elevation is matched by a remnant at Tappan Ranch and another very small remnant at Camas Creek. The 60 m terrace below Waterfall Creek is a bedrock terrace.

Gravels or terrace remnants occur above 60 m. There is a remnant at 120 m at Tappan Ranch, an occurrence of gravel at 80 m in the Big Creek Canyon and Soldier Bar at 130 m in the Big Creek Canyon. Soldier Bar is an intact, extensive feature but it is yet to be studied and measured.

There are at least 11 distinct terraces recorded within the study area, and, if one counts the certainty of Soldier Bar, the minimum number is 12. This presents a delightful set of complexities for interpreting chronology and process. This preliminary interpretation is based on comparative elevation, by no means a certain indication of contemporaniety.

Terraces, Elevations, and Process

The constructional terraces at differing elevations within the narrow confines of the Middle Fork Canyon and Tributary canyons are not all consequences of the same suite of alluvial processes. Below 20 m the terraces are surfaces of point bars which have the typical form and position of point bars. They were formed by deposition of gravel on the inside of a bend in the river. Accretion was on the down stream end and toward the center of the channel. Many clearly show the down stream back channel on the inside of the bar.

Above 20 m the terraces are not point bar surfaces. They are, rather remnants of aggredational episodes in which the canyon, or parts of the canyon were filled, raising the level of the river. The canyon is so narrow that the thought of narrow point bar deposits raised to such elevations is staggering. There simply is not room in the canyon for point bars of such size. Moreover, these higher terraces frequently occur on the outside of a bend in the river, a most inappropriate position for point bar deposition.

An important clue to the origin of these high deposits is the fact that they occur upstream from a constriction in the canyon. The alternating wide to narrow variation in the width of the canyon is caused by differential bedrock erosion. The gneiss and schist of the metasedimentary Precambrian Belt series are erosion resistant and the canyon through these rocks is very narrow and steepsided. Where the river has cut through the granitic rocks of the Idaho Batholith, which frequently are less erosion resistant, the canyon is wider. Hydraulic damming at a constriction would cause a loss of velocity and a consequent deposition of bedload upstream from the constriction and the stream would agrade in that place. Similar deposits on a much smaller scale can be observed in the river today. Later, erosion cut out these deposits, frequently leaving paired terraces on either side of the river. The 60 m terrace at the Flying B locality is a splendid example.

The 20 m terrace poses problems. In some places it appears to be a point bar. In others it appears to be a remnant of a channel fill. So, the 20 m terrace is likely the product of one process in some places and another process in other places.

<u>On Matters of Chronology</u>

The relative chronology of the terraces is assumed to be that increasing elevation equals increasing antiquity. Below 20 m this is demonstrable because each point bar is cut and filled into a higher point bar. The relative sequence up to the 20 m terrace is secure. Higher than 20 m the sequence is still assumed.

There is at the moment no sound basis for an absolute chronology for the terrace sequence. The one exposure of the Mazama volcanic ash horizon marker found was in a talus slope near Jack Creek. What can be inferred on the basis of this exposure is that the level of the Middle Fork was lower than the volcanic ash (about 6 m above present high water) at the time of the eruption of Mt. Mazama approximately 6700 years ago. From this it is possible to assume, tentatively at least, that surfaces higher than 6 m were in existence prior to the eruption of Mt. Mazama. Whether lower surfaces were already formed by that time cannot be determined on this thread of evidence.

With this one chronologic reference only very tentative statements about absolute chronology may be made. By making some long range best guess correlations, at least order of magnitude dates can be proposed.

The alluvial chronology of part of the Lower Snake River is reported by Hammatt (1976). Alluvial chronologies for the Kutenai River and an upland area of the Blue Mountains are reported by Cochran and Leonhardy (1981, 1982). These, and current studies in progress on the Clearwater and Columbia rivers not yet reported, repeatedly indicate a series of four alluvial cycles in Holocene time. In each area the earliest Holocene cycle is preceded by some event related to deglaciation, either directly or indirectly.

The following summary is from Cochran and Leonhardy (1981), the most current regional correlation. The earliest Holocene aggradation cycle began about 11,000 years ago, or before 10,700±850 radiocarbon years BP, and deposition continued to at least 7660±780 BP. There was then a period of stability and soil formation. This period of deposition is represented throughout the Pacific Northwest. There also was a wide spread erosional episode after 7660±780 but before the eruption of Mt. Mazama. Very shortly after the eruption of Mt. Mazama, sometime between 6700 and 5700 years BP there was a second alluvial cycle which has been recognized on the Clearwater River but not on the Snake River. The third alluvial cycle is as widely recognized as the first. It began after 5750±120 BP and probably just shortly before 4100±300 BP. This cycle ended about 2500 BP. The fourth alluvial cycle dates from before 1550 BP and ended only within the past 300 to 200 years.

Because the Salmon River is tributary to the Snake River and is a part of the Columbia drainage, the alluvial cycles recognized elsewhere in the drainage should be represented in the canyon of the Middle Fork. The problem is to match aggradational cycles as represented by constructional terrace surfaces to aggradational cycles represented by radiocarbon dated stratigraphic sequences.

The surfaces of stratigraphic units frequently form geomorphic units such as point bars or inset terraces. The lowest depositional surface is always associated with the youngest stratigraphic unit. Following this then, the 1 m terrace on the Middle Fork probably formed during the fourth Holocene alluvial cycle, sometime within the past 2000 years. A best guess is that both the 2.5 m and 3.5 m terraces were formed during the third cycle, approximately 4000 to 2500 years ago. Now, there is a problem of judgement with a strong possibility of being wrong; no correlation is made with the second alluvial epicycle. First, this cycle has not been as widely recognized as the others and, second the 10 m terrace fits very neatly with the elevations and extent of the first Holocene alluvial cycle which is so widely represented. The second cycle was not of the same magnitude as the cycles before and after it which probably accounts for its poor representation. The depositional regimes represented by the 10 m terrace and the 2.5 m or 3.5 m terraces simply seem to be of too great a magnitude to be the result of a minor alluvial cycle. One must emphasize the intuitive basis for this judgement however. Following this reasoning then, the 10 m terrace would date between 11,000 and 7500 years ago.

One further correlation can be suggested. In the Snake River canyon a Late Pleistocene alluvial cycle precedes the first Holocene cycle. Alluvial deposits called Valley Fill by Hammatt (1976) are stratigraphically lower than and geomorphically higher than the point bar deposits of the early Holocene cycle. The onset of this alluvial cycle was before 14,300±220 radiocarbon years BP. On the basis of included volcanic ash and radiocarbon dates, Hammatt (1976:51) dates the Valley Fill between 18,000 and 12,000 BP.

This date fits nicely with the notion that the 20 m terrace represents a channel fill which was a product of increased runoff caused by deglaciation. If so, given the current chronology of deglaciation (Clague 1981:17) the time span represented is probably more on the order 13,000 to 12,000 years ago. Current evidence indicates that deglaciation in northern Idaho and western Montana was very rapid (Bruce Cochran:personal communication)

Thus far the correlation of the Middle Fork Terrace sequence to dated geologic events in nearby regions is comparatively neat if not very precise. It is, like the rest of the project, a good first approximation.

Approximation or not, there is still a basis for making the correlations. This is not the case for terraces above 20 m. One can definitely say they are old, probably older than 13,000 years, but saying how much older is difficult.

The direct control on deposition and erosion was fluctuation in alluvial regimes caused by fluxuating glaciation and deglaciation, but there is no glacial chronology for the immediate area. Recent summaries for British Columbia (Clague 1981) and western Washington (Easterbrook 1976) provide relevent syntheses but there simply is not enough data to construct a local sequence for comparison. Most local glacial feature and the associated alluvial feature probably date from the Pinedale glacial period (Richmond 1965) which means they date from sometime after 30,000 or so years ago to 12,000 years ago. But, some of the higher deposits are feasibly pre-Pinedale and older than 30,000 years. There is no basis for greater precision.

The 60 m terrace at the Flying B locality is a prominent feature. Members of the crew were asked repeatedly how old we thought it was. It was a serious point of interest to those who travel the Middle Fork and it is a question which deserves an answer. Give the forgoing discussion of chronology it is older than 13,000 years and younger than 30,000 years. It surely represents a major event in the Quaternary history of the region. In southcentral and southeastern British Columbia there was a period of rapid aggradation preceding and during the onset of the Frazier Glaciation about 29,000 years ago (Clague 1981:13). On the basis of no data whatsoever, the 60 m terrace is assumed to represent that aggradational stage and date between 25,000 and 30,000 years ago. It is as good a guess as any.

Archaeological Implications

Comparatively level surfaces condusive to some minimal level of human comfort are comparatively rare in the mountainous area of central Idaho. Settlement is consequently constrained to places where suitable surfaces are available, so the relatively level terrace surfaces, whether they be constructional or erosional, are prime locations for archaeological sites. It is no accident that most of the archaeological sites discovered in the Middle Fork canyon and tributary canyons are associated with the terrace system. There are sites on alluvial fans and in rockshelters but most are on a terrace.

The calculus that prehistoric people used to determine settlement location was surely a complex one and included more than topography, because archaeological sites are not found on suitable surfaces at all elevations. In fact, all of those observed but one are at 10 m or below. The one exception noted is a very large site on the downstream end of the 20 m terrace at Camas Creek. The 1 m, 2.5 m, and 3.5 m terraces were the preferred surfaces and the presence of an extensive surface at these elevations is almost prima facie evidence for the presence of a site. The single observation on the 20 m terrace has been noted. All of the sites observed on the terraces of the Middle Fork and Big Creek had already been recorded, but several previously unrecorded sites were discovered along Camas Creek.

There is an apparent patterning of site location on the basis of terrace elevation. But, the other variables in the patterning calculus are not known.

The chronologic ordering of the constructional surfaces provides a set of limits for the chronology of archaeological sites. The geologic chronology controls the cultural chronology for an archaeological site can be no older than the surface it is on. This means, for instance, that sites on the 1 m terrace can be no more than 2000 years old or that a site on the 10 m terrace can date from any time during the past 7500 or more years. This knowledge can provide an initial set of chronologic boundaries for any site. Second, it provides a basis for stratifying survey or excavation samples to search for occupation from specific time periods. Looking for old sites on young terrace would be a futile endeavor.

A final implication: the terraces, whether surfaces of point bars or remnants of channel fill are products of a very high energy alluvial regime. The terrace fill is cobble to boulder gravel and the terrace surfaces are very nearly what they were when abandoned by the river. There has been very little deposition of fine textured alluvium. Only on Big Creek which has a low, even gradient above the gorge, were deposits of alluvium more than a very few centimeters thick observed. On most terraces the surface is exposed gravel or a veneer of aeolian sand except where slope wash has accumulated. Stratified open sites are going to be hard to find.

There are two depositional environments condusive to forming stratified sites in the area: the margins of alluvial fans and the canyon margin of terraces where slope wash accumulates. Thick slope wash deposits were observed repeatedly on higher terraces. They are several meters thick on the 60 m bar at the Flying B. All that is needed is the happy coincidence of prehistoric occupation, vertical deposition, and archaeological discovery.

Post Script

A small field school working for 32 days out of wilderness area camps as Forest Service volunteers recorded a surprising quantity of geoarchaeological information. Every archaeologist who has passed through or worked in the area since Earl Swanson first floated the Middle Fork has noted the terraces and frequently commented on their archaeological significance. The present work was devoted to the study of terraces attempting to discover their nature, number and order. Parenthetically, acknowledgement should be made to a set of air photos on file at the University of Idaho Laboratory of Anthropology on which numerous surfaces along the Middle Fork have been delinated and marked with designations indicating a previous attempt to impose some kind of order on the complexity of level surfaces in the Middle Fork Canyon. The person who did this work is unknown.

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