CHAPTER 5

Geoarchaeology of the Colorado River in Grand Canyon

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Until recently, there has been a notable lack of research geared toward understanding and interpreting Grand Canyon prehistory in the context of the Canyon's dynamically evolving landscape. This paper is a beginning attempt to rectify this deficiency by summarizing and interpreting the results of geoarchaeological research along the Colorado River in Grand Canyon National Park. The current research builds on the foundation of archaeological knowledge laid down by Dr. Robert Euler during his three-plus decades of research at Grand Canyon. The results of this recent work reaffirm the value—long emphasized by Dr. Euler—of incorporating geomorphological information and other interdisciplinary perspectives into archaeological studies to unravel the complexities of the past, both within and beyond the Canyon's rims.

The data for this paper are derived primarily from a series of studies funded by the Bureau of Reclamation between 1989 and 1996 to assess the effects of the operation of Glen Canyon Dam on downstream archaeological resources. An intensive survey conducted between 1990 and 1991 along a 255-mile (410-km) stretch of the river identified 475 archaeological sites (Fairley et al. 1994), about 300 of which were later determined to be susceptible to the direct or indirect effects of dam operation. In order to develop appropriate management recommendations for future operation of Glen Canyon Dam, the National Park Service enlisted the expertise of U.S. Geological Survey geologists Richard Hereford and Ivo Lucchitta to map and interpret the geomorphic setting of the archaeological sites. Hereford's work focused exclusively on the Holocene age sedimentary deposits, while Lucchitta et al. (1995) examined the Quaternary setting as a whole. This paper deals primarily with the work by Hereford and others (Burke et al. n.d.; Hereford 1996; Hereford, Burke, and Thompson 1998, 2000a, 2000b; Hereford et al. 1993, 1996; Hereford, Thompson, and Burke 1998) on the Holocene context of archaeological sites within the Grand Canyon river corridor.

Since the late 1960s, if not earlier, Dr. Euler has promoted the use of natural and cultural stratigraphy and interdisciplinary perspectives to interpret environmental parameters affecting archaeological sites in Grand Canyon. Euler has also led the field by example. Following his pioneering studies at Stanton's Cave (Euler 1984), Euler advocated the excavation of additional stratified sites in the Canyon to place previous findings into broader environmental and cultural historical perspectives (Euler 1974). Beginning in the 1970s, Euler repeatedly submitted proposals to the National Park Service to undertake excavations at several stratified rock shelters to expand and refine our understanding of the Canyon's prehistory. Year after year his proposals went unfunded, but he doggedly resubmitted them. Finally, in 1984, shortly before he retired from the National Park Service, funding for test excavations at five sites was approved. The task of conducting these excavations ultimately fell to NPS archaeologist Trinkle Jones (1986). The results of Jones's project confirmed what had long been suspected: that Grand Canyon prehistory was not as simple as surface evidence suggested. Our more recent studies have soundly reaffirmed that finding.

While the ultimate aim of the recent geomorphological research was to develop a model of site erosion susceptibility (Balsom and Fairley 1989), this research has also provided a great deal of information about the physical context of the archaeological sites, the nature of the sites themselves, and the natural processes that have acted on those sites. These discoveries have important implications for future planning and management of archaeological resources in the river corridor (Thompson and Bettis 1982).

To understand the close relationship between geomorphology and archaeology in the river corridor, some background information on the Colorado River is required. Before construction of Glen Canyon Dam, the Colorado River fluctuated dramatically on an annual basis. Flows often exceeded 80,000 cubic feet per second (cfs) in late spring and dropped below 5,000 cfs in the dry fall months (Carothers and Brown 1991). Peak runoff typically occurred in late May and June from melting of the snow pack in the Rocky Mountains. Secondary peaks could occur in July–August and mid-winter months due to localized storms. Flood flows carried tremendous sediment loads: over 1.8 million tons of sand, silt, and clay could be transported past a given point on a single day (Robert Hart, personal communication 1992). Between 1941 and 1957, on average more than 85 million tons of sediment were transported through the Inner Gorge of Grand Canyon every year. For 15 years prior to 1941 the average annual sediment load was 195 million tons (Andrews 1991:63).

As floodwaters receded each year, the river would deposit sediment in recirculating backwater areas above and below rapids, as well as along the riverbanks (Howard and Dolan 1981). Occasionally the river flooded well above the average spring maximum flow of 85,000 cfs. USGS gauging records documented a flood exceeding 220,000 cfs in the early summer of 1921, and multiple floods in excess of 300,000 cfs are known from the geomorphological record (O'Connor et al. 1994). Sediment deposited by these exceptional floods could remain in place at higher elevations above the river for centuries, even millennia. Subsequent floods carved and reshaped these high terraces, while wind action reworked their surfaces, forming extensive dunes. Occasional debris flows from side canyons overtopped and capped old terrace surfaces (Webb et al. 1989). Prehistoric people subsequently selected many of the higher sandy terraces for habitation and specialized activities. Of the roughly 300 sites in the zone of potential effect from dam operations, more than 230 are on or in alluvium deposited by the Colorado River (Fairley et al. 1994:148).

The geomorphological research reported here focused on four main areas in Grand Canyon containing extensive alluvial deposits (Figure 5.1): Lee's Ferry at River Mile 0, the Nankoweap area between River Miles 52 and 53, the Palisades-to-Unkar Creek reach between Miles 65 and 70 (known locally as "Furnace Flats"), and the Granite Park area between Miles 207 and 209. An interdisciplinary core team consisting of a geomorphologist, a soil scientist, a structural geologist, and an archaeologist carried out the field studies. Grain size and sedimentary structure analyses were the principal means of discerning the mechanisms of deposition. Radiocarbon dating of natural and cultural materials, ceramic dating of archaeological sites, tree-ring dating of live trees and driftwood, and relative dating of weathered limestone boulders were the principal methods used to establish age controls on the terrace deposits. Sorted by type and age, the depositional units were mapped onto large-scale aerial photos and transferred onto specially prepared large-scale topographic maps.

Hereford subdivided the pre-dam Holocene deposits into five alluvial terraces (Figure 5.2). From oldest to youngest, the five deposits were assigned field names as follows: Striped Alluvium, Alluvium of Pueblo II Age, Upper and Lower Mesquite Terrace Alluvium, and Pre-dam Alluvium. These deposits form discontinuous and unpaired terraces upstream from, downstream from, and encircling Holocene debris fans at the mouths of tributary canyons. Each terrace occupies a distinctive topographic position, with the oldest terrace usually highest and generally farthest from the river, though there are exceptions to this pattern. The units partly overlap in subsurface contexts, and areas of overlap between units represent erosional hiatuses.

The two oldest identified Holocene deposits in the river corridor are the Striped Alluvium and the Alluvium of Pueblo II Age. Prehistoric remains are found both on and in these deposits, but only aceramic remains have been found within the Striped Alluvium. The Striped Alluvium consists of light beige, very fine grained sand interbedded with layers 5–15 cm thick of dark red sand and gravel derived from nearby slopes. This interbed-

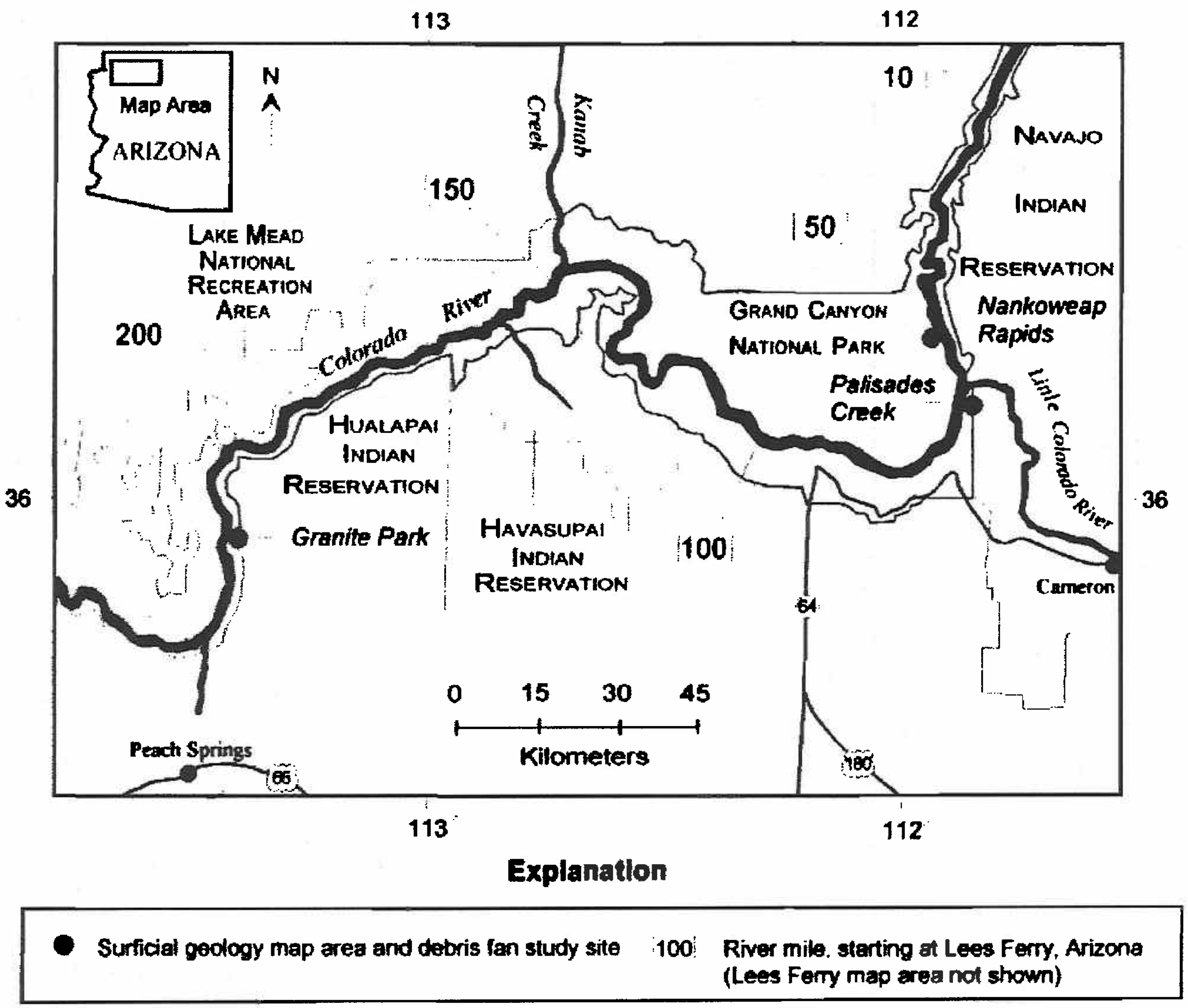


Figure 5.1. Study area in Grand Canyon National Park, Arizona.

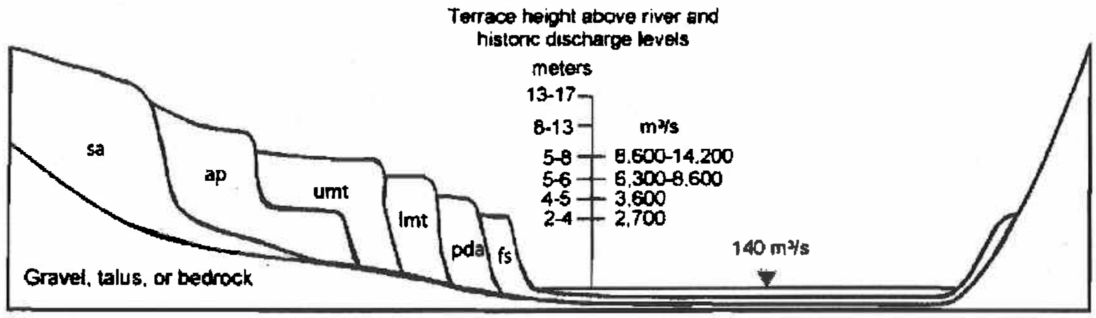


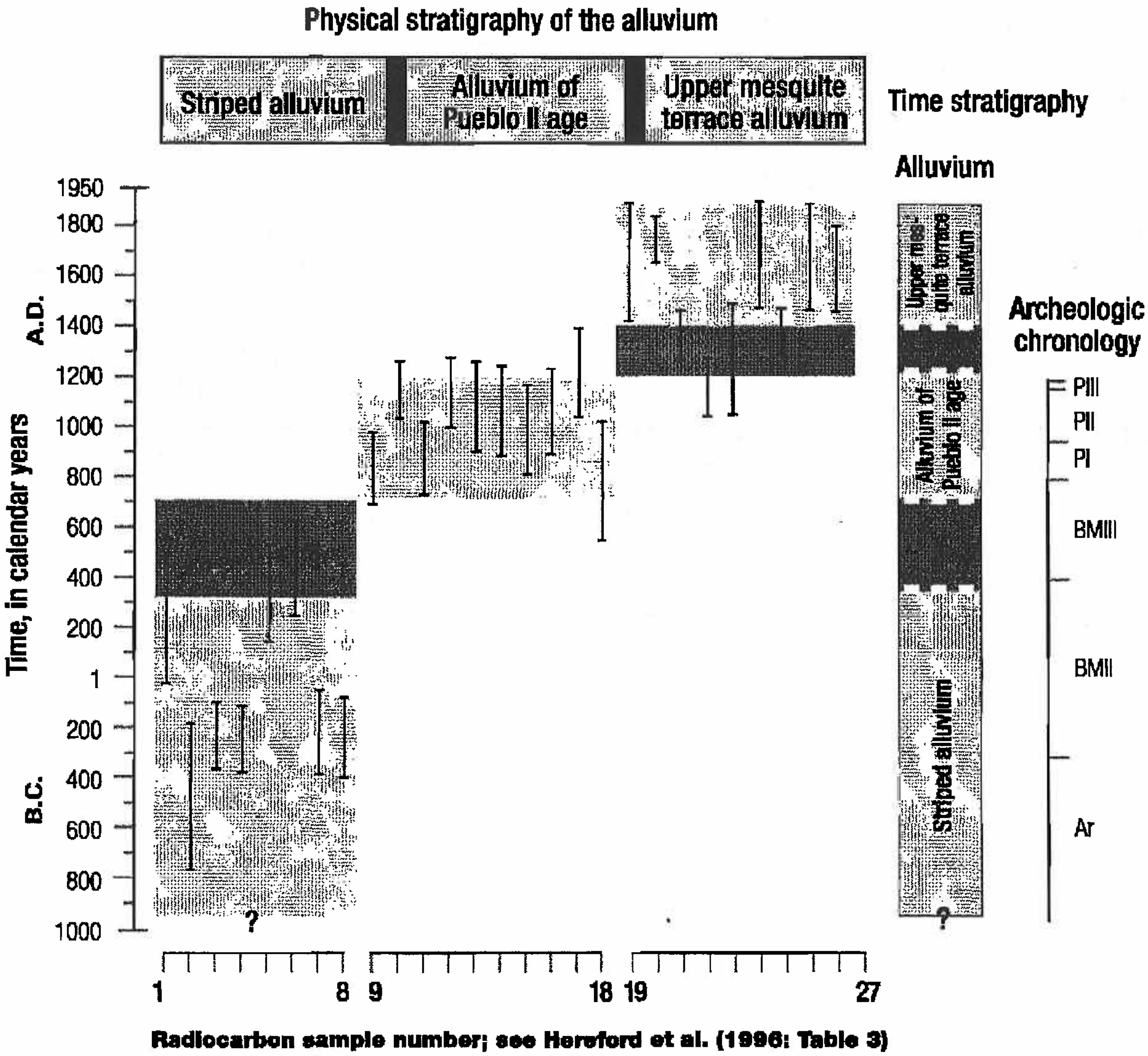
Figure 5.2. Schematic cross section of late Holocene terraces and related deposits.

ding of dark slope wash material with the light sand of mostly fluvial origin imparts the distinctive "stripes" that characterize the deposit in eastern Grand Canyon.

The alluvium of Pueblo II age derives its name from the locally abundant Pueblo II archaeological materials found on and near the surface of this deposit. Artifacts diagnostic of the Pueblo I period or Coconino focus are found buried near the base of this alluvial unit, and early Pueblo III artifacts and later remains may be found on the terrace surface. This deposit consists mainly of pale, poorly sorted, very fine grained sand of fluvial origin, interbedded locally with moderately well sorted sand of probable eolian origin. Occasional interbedded sand and gravel derived from adjacent slopes are also present, but they are not as conspicuous as those in the Striped Alluvium. In some places, the Alluvium of Pueblo II Age disconformably overlies the Striped Alluvium. The contact between the two units is an eroded surface with up to 1 m of local relief, and stratification in the Striped Alluvium is truncated at this contact. Thus, the Alluvium of Pueblo II Age is stratigraphically distinguishable from the striped alluvium, though in places there is little or no topographic separation at the surface.

The Upper and Lower Mesquite Terrace alluviums range from narrow discontinuous scour zones to well-developed, easily discernible terraces. In eastern Grand Canyon they are topographically below the terraces of the Striped and Pueblo II Age alluviums. This topographic situation does not hold up in the Granite Park reach, where the Upper Mesquite alluvium overtops the Pueblo II Age terrace (Hereford et al. 2000a). Abundant, fairly large, mature mesquites are present on the older, Upper Mesquite Terrace, while much smaller and obviously younger mesquite trees are present on the Lower Mesquite Terrace. Like the Pueblo alluvium, the Upper and Lower Mesquite Terraces are composed mostly of light beige, poorly sorted, very fine grained silty sand of Colorado River origin.

Age ranges of the Striped, Pueblo II Age, and Upper Mesquite Terrace alluviums are constrained by radiocarbon dates and archaeological materials. In eastern Grand Canyon, the radiocarbon results indicate that deposition of the Striped Alluvium began prior to 800 B.C. and lasted until about A.D. 300 (Figure 5.3). In the Granite Park area, a date of 2870 ± 60 BP from a deeply buried cultural stratum indicates that deposition of the Striped Alluvium may have commenced prior to 1300 B.C. In upper Marble Canyon, even older dates are known. O'Connor et al. (1994) dated the base of a sequence that appears to be equivalent to the Striped Alluvium at 2500 B.C. This age range of 2500 B.C. to A.D. 300 for the Striped Alluvium is consistent with the aceramic character of the archaeological remains embedded within this deposit. Although no diagnostic tools have been recovered, the radiocarbon data demonstrate that the Striped Alluvium is temporally equivalent with the Late Archaic period and most of the Basketmaker II period.



EXPLANATION

Archeologic chronology		*Alluvial stratigraphy*	*Radiocarbon dates*
PIII	Early Pueblo III	Erosional contact	95% confidence interval of calibrated date, or upper and lower range of multiple dates
PII	Pueblo II		
PI	Pueblo I	Inferred time of erosion	
BMIII	Basketmaker III		
BMII	Basketmaker II		
Ar	Late archaic	Inferred time of deposition	

Figure 5.3. Radiocarbon dates from late Holocene alluvium, eastern Grand Canyon. Additional dates can be found in Hereford, Burke, and Thompson (1998, 2000a, 2000b).

A period of erosion and non-deposition between the Striped and Pueblo II Age alluviums appears to have lasted about 400 years, from about A.D. 300 to 700, coinciding with the end of the Basketmaker II period and most of Basketmaker III. The beginning date for deposition of the Pueblo II Age alluvium, about A.D. 700, is suggested by the presence of Pueblo I sherds near the base of the alluvium in the Upper Unkar area. The assemblage includes Deadmans Gray, Floyd Black-on-gray, and Deadmans Black-on-red, which date about A.D. 750–900. A similar assemblage was also found in the Palisades area, stratigraphically separated from and underlying an early Pueblo II assemblage containing Coconino Gray, Medicine Black-on-red, and early versions of Black Mesa Black-on-white. Sites with late Pueblo II sherds are common in the uppermost level of the Pueblo II Age terrace, and early Pueblo III ceramics are found in few locations on the surface of this terrace, suggesting that deposition of this alluvial unit ended between A.D. 1150 and 1200, more or less coinciding with the depopulation of the area by the Anasazi.

Based on radiocarbon data, a lack of Anasazi remains, and geomorphic relationships, the Upper Mesquite Terrace alluvium clearly postdates A.D. 1200. Radiocarbon dates on ancient mesquites and roasting features indicate that deposition of Upper Mesquite alluvium could have begun as late as A.D. 1400. Thus, the erosional hiatus between the Alluvium of Pueblo II Age and that of the Upper Mesquite Terrace apparently lasted about 200 years, between A.D. 1200 and 1400. Finally, driftwood stands containing sparse cut wood, in conjunction with historic photographic evidence, correlate the Lower Mesquite Terrace with a late nineteenth century flood event, probably the flood of 1884.

How do these geomorphic findings affect our current interpretations of Grand Canyon prehistory? First, while they demonstrate clear correlations with the principal eras of human occupation in Grand Canyon (Euler 1967, 1969), they simultaneously suggest that we should be cautious about interpreting hiatuses in the archaeological record as being synonymous with occupational abandonments. The current paucity of evidence for use of the Inner Canyon during the Early and Middle Archaic periods, the Basketmaker III period, and the crucial transition from the Formative period to the Protohistoric period (in the thirteenth and fourteenth centuries A.D.) may have more to do with the lack of sediment preservation than with human use patterns.

Second, the geomorphic studies make it clear that if we want to locate sites predating the Basketmaker and Puebloan eras, we need to look in those areas where Archaic period deposits are still preserved. Despite extensive efforts to locate deeply buried cultural remains, the oldest dated cultural deposits in our study areas came in at about 1300 B.C. Upstream near Lees Ferry, another team of researchers working on a reconstruction of Colorado River paleoflood history located one stratigraphic sequence that included a deeply buried hearth dating between 4520 and 4240 BP (O'Connor et al. 1994:5), contemporary with the earliest split-twig figurines in Grand Canyon. NPS archaeologists recently dated another hearth in this same area between 3220 and 3560 BP (Lisa Leap, personal communication 2001). Farther upstream from Lees Ferry, noncultural organic remains preserved within alluvial sediments produced additional dates in the same time range. Thus, the current evidence suggests that the most likely localities for in situ Archaic campsites along the Colorado River are to be found in lower Glen Canyon and upper Marble Canyon, where remnants of alluvial terraces dating to that period are still preserved.

Another important outcome of the geomorphic research was the recognition of occupational episodes during time periods that were previously poorly represented in the archaeological record. For example, one unanticipated outcome was the identification of several preceramic hearths near River Mile 68 (in the vicinity of Tanner Wash). Wood charcoal from the hearths dated between 1700 and 2400 BP. Taking into account the "old wood" factor, these features appear to be contemporaneous with the Basketmaker II period elsewhere on the southern Colorado Plateau. Only two other inner canyon sites, both rock shelters tested by Jones in 1984, produced dates that fall squarely in the Basketmaker II time range (Jones 1986:105). Whether the Tanner sites are affiliated with the earliest Anasazi or with the preceramic antecedents of the Cohonina culture is a question that deserves further consideration. The recent identification of corn pollen within the Striped Alluvium near the mouth of Comanche Creek (Davis et al. 2000), with dates possibly as early as 1320 B.C., suggests that whoever created the Tanner hearths may also have been practicing horticulture (although the presence of corn pollen in reworked alluvial deposits, by itself, is not unequivocal evidence of agriculture [R. G. Matson, personal communication 2001]). Clearly, more detailed studies of the features and other cultural deposits in the Striped Alluvium are needed, as these deposits may contain some of the key evidence required for unraveling the story of early agriculture on the Colorado Plateau.

The foregoing discussion illustrates the importance of examining the full stratigraphic sequence of alluvial deposits in the river corridor to understand the temporal depth and complexity of Grand Canyon prehistory. It is also important to examine the spatial distribution of alluvial deposits throughout the river corridor if we wish to interpret cultural interactions correctly (Hajic 1985; Hajic and Styles 1982). Using survey data, Fairley and others (1994:106) noted the paucity of Pueblo II remains in the western canyon relative to the eastern canyon; they concluded that Pueblo II populations used the western canyon only seasonally, during forays from residences at higher elevations to the north. They further speculated that the sparse and patchy distribution of Pueblo II sites west of Kanab Creek might reflect a cultural frontier in this part of the Grand Canyon, with the river corridor serving as a boundary zone between the Virgin Anasazi north of the Canyon and the Cohonina to the south. Geomorphological work conducted in the Granite Park area between 1992 and 1995 suggests an alternative explanation. One mile (1.6 km) upstream from Granite Park, in an area informally named "Arroyo Grande," alluvium equivalent in age to the Pueblo II Age unit was found to be inset against the local equivalent of the Striped unit, but both older units were truncated and overtopped by alluvium contemporaneous with the Upper Mesquite Terrace unit. As was noted, this younger unit is normally topographically lower than the Pueblo II Age terraces in eastern Grand Canyon. In the Arroyo Grande area, however, the entire terrace surface was capped by this unit of protohistoric age, effectively covering any Pueblo II and earlier sites. If future studies confirm that overtopping of older deposits by the Upper Mesquite Terrace alluvium is a widespread phenomenon in western Grand Canyon, they would provide an alternative explanation for the relative lack of Pueblo II and earlier remains in that part of the canyon, especially compared to the many Protohistoric period roasting pit sites found in the same area. In other words, the relative infrequency of Pueblo II remains may have little to do with cultural boundary phenomena or prehistoric abundance and everything to do with surface visibility.

Other interesting issues relating to the prehistory of Grand Canyon (and especially to prehistoric climate) can be addressed by further study of the alluvial deposits in Grand Canyon. Suffice it to say that the alluvial chronology of the Colorado River in Grand Canyon seems to correlate broadly with the late Holocene chronology of the southern Colorado Plateau (Figure 5:4) as outlined by Hack (1942), refined by Euler and others

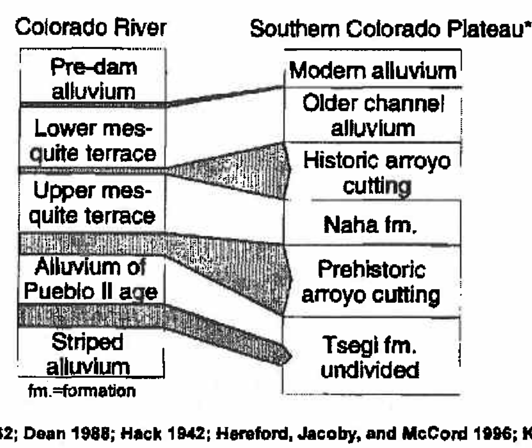


Figure 5.4. Correlation of late Holocene alluvium along the Colorado River with alluvium in Colorado Plateau tributary streams.

(1979), and subsequently elaborated by Dean (1988:129) and Karlstrom (1988). This of course has important implications for interpreting Grand Canyon prehistory in a regional context.

Clearly, there is still a great deal to be learned from studying the alluvial deposits along the Colorado River in Grand Canyon. Let us hope that the measures being undertaken today to help preserve the remaining Holocene sediments in the river corridor prove effective. We stand to loose a great deal if we fail in our efforts to preserve them, not only in terms of the archaeological sites themselves, but in terms of the valuable information these deposits can contribute to furthering our understanding of regional climate, the history of landscape evolution in Grand Canyon, and the effects of physical processes on interpretations of the archaeological record.

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