

# The Hot Tubb Folsom-Midland Site (41 CR 10), Texas

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*The Hot Tubb locality, located in the Monahans Dunes just off the southern High Plains of west Texas, has yielded Folsom and Midland projectile points, as well as badly fragmented and occasionally burned remains of *Bison antiquus*. Because these materials occur primarily on the surface of a deflation basin within an active sand dune, which also contains artifacts of later age, the Paleoindian component cannot be easily isolated, nor have attempts to determine its radiocarbon age been successful. Nonetheless, the distribution and density of the bone and diagnostic Folsom material indicate there is spatial and possibly stratigraphic integrity to this component, which makes it possible to discern where and what Paleoindian activity may have occurred on site. We infer this was a small Folsom-age bison kill and processing locality of an estimated six animals. The lithic assemblage is marked by intensive reworking and even re-fluting of projectile points, suggesting that the supply of stone, originally acquired at sources at least 150 km distant, was low by the time of this occupation. That dearth of stone, the presence of Midland points, as well as a possible Midland point preform, may also shed some light on the longstanding 'Folsom-Midland Problem.'*

**Keywords:** *Paleoindian, Folsom, Midland, bison, sand dune archaeology*

The archaeological record of the Folsom period in Late Glacial times (ca. 10,900 to 10,200 <sup>14</sup>C years B.P.) is seemingly dominated by large bison kills, and these strongly influence our interpretations of human adaptations during this period in prehistory (Hofman and Todd 2001). Yet, such sites comprise less than five percent of all known Folsom localities (LaBelle et al. 2003; also Frison et al. 1996). The vast majority of Folsom age sites on the Plains are smaller kills, quarry or quarry-related localities, small lithic scatters, and isolated fluted point finds (Amick 1994, 1995; Blackmar 2001; Frison et al. 1996; Hofman 1999; Jodry 1999; LaBelle 2005, LaBelle et al. 2003; Largent et al. 1991, LeTourneau 2000; Meltzer 2006). In this regard, the southern High Plains is unexceptional (Amick 1994; LeTourneau 2000).

However, the southern High Plains is unusual in one respect: with a couple of highly localized

exceptions (e.g. the Alibates and Tecovas source areas), this is a region virtually devoid of outcrops of the high quality stone preferred by Folsom groups (Holliday 1997). There are very few quarry or quarry-related Folsom sites, and certainly none to rival those sites in, for example, the Knife River Flint Quarry area (e.g. Root, ed. 2000; William 2000). The scarcity of ready stone sources makes the southern High Plains a prime area for exploring Folsom mobility, technology, and land use, on a landscape where a vital resource was scarce and had to be obtained at sources distant in space or time (Amick 1995, 1996; Hofman 1991, 1992, 1999). Indeed, a possible entailment of the scarcity of lithic raw material is the appearance of a distinctive projectile point — the Midland type — alongside Folsom projectile points in some assemblages. There has been much discussion of what these separate point types represent, and whether

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the differences are historically meaningful — such as stylistic or technological differences among groups on the landscape at different times or places — or whether they were forms used contemporaneously or even by the same group, perhaps as a result of the progressive loss and recycling of material in stone poor areas (Agogino 1969; Amick 1995; Blaine 1968; Hofman 1992; Judge 1970; Wendorf and Krieger 1959).

That said, the precise distribution of Midland points, their co-occurrence with Folsom forms, and their technology is not as well understood as it might be, in part because of a dearth of Folsom-Midland sites and assemblages (but see Amick 1995; Hofman et al. 1990). To help rectify that situation and provide additional information on Paleoindians on the southern High Plains, data are here provided on a recently investigated Folsom-Midland occupation at the Hot Tubb site, in Crane County, Texas (41CR10).

### BACKGROUND TO THE INVESTIGATIONS

Hot Tubb was discovered in 1984 by an oilfield worker/artifact collector who found three Folsom projectile points along the margins of a large deflation basin. The points were reportedly in association with a number of bison bones, many complete. An additional two or three Folsom projectile points were recovered during a subsequent visit to the locality, as were a number of apparent Paleoindian-style snub-nosed endscrapers. Realizing the importance of his find — Folsom Paleoindian sites are rare in Crane County (Harrell 1995; see also Largent et al. 1991) — in the late spring of 1984 the collector reported the site to archaeologist Michael Collins.

Collins and others subsequently visited the site in September 1984. Large bison bones, presumably of Folsom age, were again observed on the surface and what was identified as a Folsom graver was also recovered (Collins, 41CR10 site file, Texas Archaeological Research Laboratory, University of Texas [hereafter, TARL]). The bones were thought to be eroding from within or atop a white sand observed directly underneath the modern tan aeolian blow sand. Hot Tubb's discoverer reported the white sand had also yielded his previously discovered Folsom tools. As the only arti-

facts found in the tan aeolian blow sand were from later periods, Collins considered the Hot Tubb Folsom component to have the potential for both spatial and stratigraphic integrity, and the white sand to be of Pleistocene age (Collins, 41CR10 site file and unpublished fieldnotes, TARL). However, he also noted that because Archaic-age points, burned caliche, and other artifacts from the overlying sands were apparently deflating onto the same surface, "the site will be difficult to interpret prior to excavation ... making segregation of non-diagnostic artifacts problematic" (Collins, 41CR10 site file, TARL). Even so, Collins identified Hot Tubb as an intact Folsom bison kill, one with the potential for an "unmixed, buried Folsom component" (Collins, unpublished field notes). No fieldwork was initiated at that time.

Brief visits to the site were made in the years that followed. In September 1989, Collins and Stephen Stokes spent a day on site as part of a larger project by Stokes (e.g. Rich and Stokes 2001) to collect sediment samples on the southern Plains for optically stimulated luminescence (OSL) dating. On that occasion, Collins observed that erosion in the five years since his first visit had significantly expanded the blowout (Collins field notes, 1989). He and Stokes put in several small test pits, in one of which a 'bonebed' was encountered 90 cm below surface. Samples for OSL dating were taken from above and below the bonebed, at depths of 75 cm (in yellowish brown sand) and 125 cm (in pale brown sand) below the surface, respectively (Stephen Stokes, personal communication 2003).

Richard Rose, an avocational archaeologist in the region who participated in the initial 1984 visit, also returned to the site on a couple of occasions in later years. On those trips he collected two Folsom fluted points. Rose observed, however, that those points did not appear to come from the white sand reported by Collins, but instead from a dark, buried soil visible along the eroding margins of the blowout.

The next recorded visit to the site was made in June 2001 by Rose, Meltzer, and Vance Holliday. A single morning's reconnaissance was made to re-locate the site and ascertain its potential for systematic field investigations. On that visit, the site yielded no diagnostic artifacts, but concentrations

of faunal remains were apparent on the surface. However, where in 1984 Collins and others had seen complete, or almost complete, bison skeletal elements, by 2001 the bone on the surface had degraded into a mass of fragments. A small collection ( $n < 20$ ) of complete faunal elements, primarily distal limbs, was made for the purpose of more precise taxonomic identification. Rose donated a proximal bison rib shaft segment collected from the site, which was submitted for radiocarbon dating that fall. Unfortunately, it lacked sufficient organic material to yield an age.

Even so, the occurrence of multiple Folsom points in what appeared to be a relatively small area, the concentration of bison bone possibly with the Folsom artifacts, and the potential for in situ remains associated with the buried soil still visible in the blowout and perhaps even some stratigraphic integrity and intact subsurface deposits, all seemed to warrant further field investigation. Accordingly, fieldwork at Hot Tubb was conducted in 2002 and 2003. Two 10-day sessions were spent there each season. Fieldwork entailed survey and surface collection, a program of 'surface skims' (explained below), and limited excavation. When available, artifacts recovered from the site on previous visits were examined.

### SITE SETTING

Hot Tubb is located along the eastern margin of the Pecos River Valley, just off the southern edge of the southern High Plains, roughly equidistant along a diagonal drawn between the towns of Crane and Monahans, Texas (Figure 1). Winters in this region are relatively mild; the daily minimum temperatures in December and January drop below freezing (32° F) approximately 16–20 days of the month (at Crane and Monahans, respectively), but the minimum temperatures will rarely drop below 0° F. Only one day in the last 40 years of data from these weather stations had a recorded winter minimum below 0° F. In contrast, summers are hot: on average,

daytime temperatures are above 90° F (32.2° C) for 119 days of the year in Crane, and 129 days of the year at Monahans (National Climate Data Center 2004)

This is a semi-arid region, averaging from 35 cm to 38 cm of precipitation per year (National Climate Data Center 2004). Since the majority of the annual precipitation occurs during the summer when temperatures are highest, often associated with convection thunderstorms, evaporation rates are correspondingly high.

The ecology of the area reflects the hot and dry climate. The area is open scrub and mesquite grassland (Bailey 1995; Shelford 1963), but bears some resemblance in its flora and fauna to that of the Chihuahuan Desert to the south and southwest (Blair 1950; Schmidt 1979). Although honey mesquite (*Prosopis glandulosa*) is the dominant woody form, it is a relatively recent arrival in this region

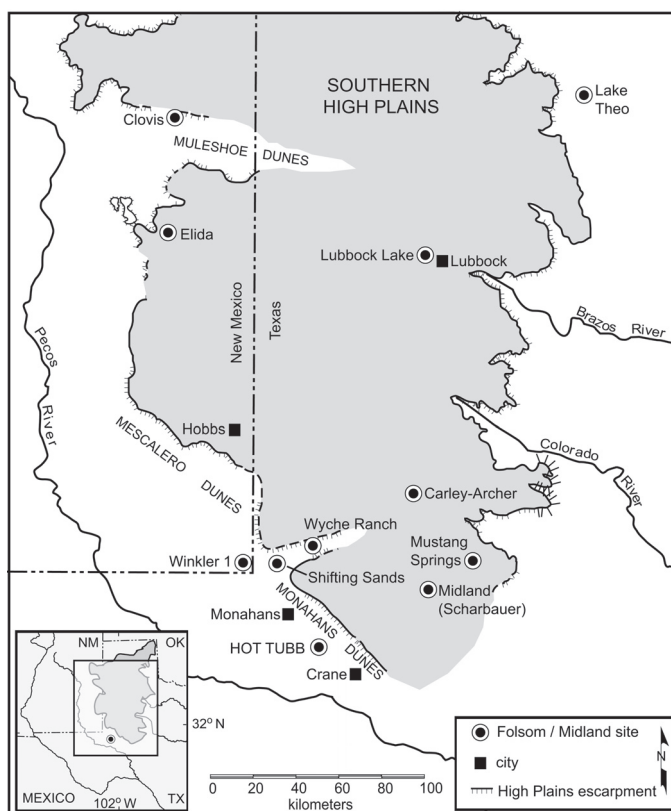


Figure 1. The southern High Plains region, showing the location of Hot Tubb and other Folsom/Midland sites mentioned in the text.

(Boutton et al. 2004). Prior to the infestation of mesquite, the area was likely more open, marked by grasses (including various species of grama, buffalograss, bluestem, threeawn, fescue, wheatgrass and dropseed), and various forbs, shrubs and woody plants such as sagebrush, sumac, yarrow, broomweed, ragweed, catclaw acacia, hackberry, and gambel oak (Stubbendieck et al. 1992; Wendorf 1961). The relative extent and nature of the ground cover of grasses and shrubs varies in response to even slight changes in available moisture.

In places within this region there are extensive and active sand dunes. The Hot Tubb site is situated within the Monahans Dunes (Green 1961; Holliday 2001; Muhs and Holliday 2001), which extend northwest to southeast through the southeast corner of New Mexico, blanketing the eastern side of the Pecos River Valley and lapping up against the margin of the southern High Plains (Green 1961:Figure 5; Holliday 2001:Figure 9; Muhs and Holliday 2001:Figures 2 and 5).

Age control is not available on the Hot Tubb dunes, but the sequence here is probably similar to that of other portions of the Monahans Dune system, as detailed in Holliday (2001). Initial mobilization and deposition of sand likely began with episodic drought of Late Glacial (Folsom) times (Holliday 2000). Deposition continued through the Early Holocene (Holliday 2001:98, 102). Following a period of surface stability, dunes were likely reactivated during the Middle Holocene (Altithermal), although evidence of sand of this age on upland surfaces are rare, owing to still later dune activity 'cannibalizing' Middle Holocene dune deposits (Holliday 2001; Meltzer 1999). Re-activation appears to have begun ca. 2500 <sup>14</sup>C years B.P., following a several thousand year period of landscape stability in post-Altithermal times (Holliday 2001:98).

Although these periods of deflation, erosion, and dune activity would be expected to have a deleterious impact on the archeological remains at Hot Tubb, the observation in 1984 of complete bison bone elements and a possible intact surface on which they occurred suggests that any degradation up to that time was localized or minimal. However, given the condition of the site and bison bone in 2001, it would appear that exposure and considerable damage occurred in the intervening two

decades. This would suggest that throughout the Holocene, despite evidence for region-wide episodes of repeated dune activation, exposure and re-burial, the Hot Tubb bonebed remained largely covered and intact. That does not mean there were not episodes of exposure and reburial, or that stratigraphic mixing or lagging did not also occur.

The Hot Tubb site, as initially demarcated by Collins, consisted of three separate dune blowouts. Localities 1 and 3 are dominated by artifacts of later periods, including grinding stones and a considerable amount of burned caliche. A single Paleoindian projectile point was recovered by Rose in Locality 3, but there is otherwise little indication in this area of any Paleoindian archaeological presence. With that exception, all diagnostic Paleoindian remains from Hot Tubb have been recovered from Locality 2, which is also where the bison bone is found. Our fieldwork therefore focused on Locality 2, and the discussion that follows refers to this area, unless otherwise noted.

At present, Locality 2 extends over ~10,000 m<sup>2</sup>. Because it is within active dunes, its current configuration is ephemeral — at least on an archaeological time scale. Granting that, Locality 2 is roughly horseshoe-shaped, and for the sake of discussion can be further divided into four quadrants, using the North 965 and East 975 grid lines as the dividing lines (Figure 2). That division is not wholly arbitrary, but instead is based roughly on topography and on the density of archaeological material on the surface (Figure 2). The main blowout of Locality 2 consists of the NE and SE quadrants. This is the largest portion of the deflation basin, and is surrounded by dunes, the crests of which are as much as 9 m higher than the deepest part of the basin. The SW and NW quadrants lead into the main blowout, and are shallower, narrower, and oriented at right angles to it.

Presently, very little vegetation occurs within the deflation basin or on its immediate flanks. However, beyond the margins of the deflation basin the dunes support a patchy cover of gambel oak (*Quercus havardii*), honey mesquite, as well as spotty areas of grasses and shrubs (Figure 3).

## FIELD METHODS

The archaeological situation at Hot Tubb presented a challenge. The vagaries of preservation



and movement of artifacts and bone in sand dune sites are well-known. All of the artifacts collected from the site on previous visits were from the surface; these included not only Folsom artifacts, but also Archaic forms, including burned caliche, assumed to be from later, non-Paleoindian periods. Obviously, there was a strong possibility that the cultural remains at the site were temporally mixed. Compounding this problem was the lack of age control on the bison bones, and the fragmentation of those remains that occurred between 1984 and 2001. It was not certain at the outset that these bison bones dated to Folsom times; their condition provided little opportunity to gather the data necessary to ascertain if they were within the size range of the extinct Pleistocene *Bison antiquus*.

The initial field effort involved the establishment of two permanent datums, HTA and HTB, in the NE and NW quadrants respectively, and topographic mapping using EDM/Total Stations of Locality 2 and the immediately surrounding dunes. In the course of this effort, an intensive surface collection was carried out. Because of the density of the cultural and

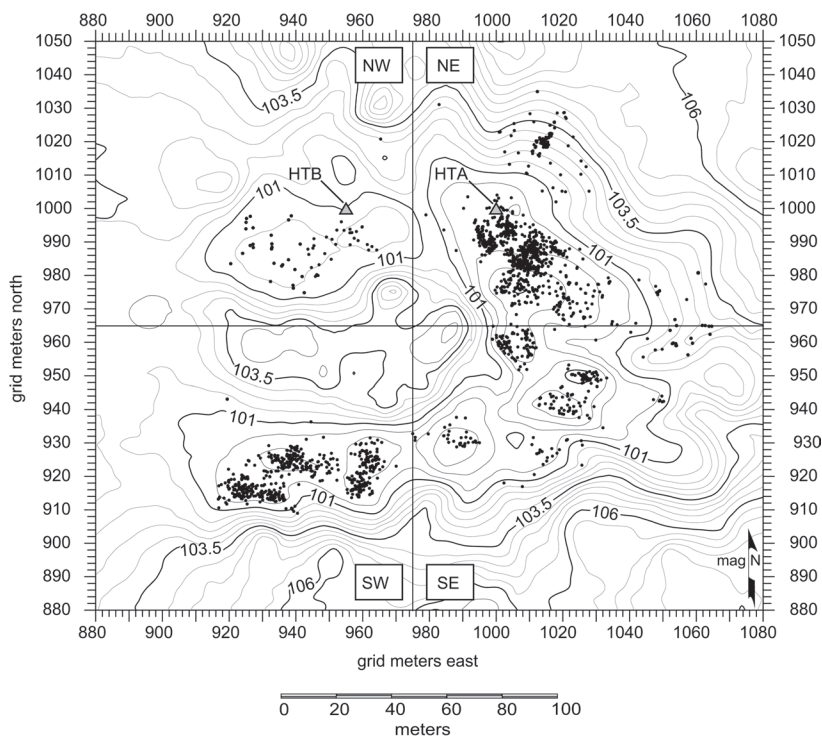


Figure 2. Topographic base map of Locality 2 at Hot Tubb showing quadrants and piece plotted surface items.



Figure 3. Photograph of Locality 2 at Hot Tubb, looking north, June 2002 (photograph by D.J. Meltzer).

faunal material, arbitrary size cutoffs for collection were employed. Only faunal remains at or above 2 cm in maximum length were mapped and collected, as were lithic artifacts if they were more than 1 cm in length. Slightly over 2000 specimens ( $n = 2029$ ) were obtained in this manner over the two seasons of field work. This total includes chipped stone (primarily debitage and a very small percentage of formal tools), small bones and bone fragments (~45 percent of the total number of items), along with a minor amount of ground stone artifacts and burned caliche.

Given that the surface of the deflation basin is active sand, those items atop the surface were not in a different stratigraphic level than those immediately below the surface in the unconsolidated cover sands that blanket the site. The artifacts atop the surface merely happened to be the ones visible at that particular moment, owing to the movement of the sand by wind, animals, or crew members. That being the case, it was decided to collect as a single unit all of the artifacts and bones in the unconsolidated cover sands. This effort involved 'surface skimming,' in which the loose cover sand in individual 1 m x 1 m units was collected down to the stratigraphic contact with the underlying consolidated sands. The cover sand was then screened through 1/8 inch (0.125 cm) mesh. A contiguous block (including a projecting trench line) of 362 m<sup>2</sup> was surface skimmed in this manner. As the cover sand was on average ~10 cm thick, this represents a volume of ~36.2 m<sup>3</sup> of sand passed through 1/8 inch mesh. A few additional skim units were just west of that block. All of the surface skims were within the NE quadrant (Figure 4).

In order to test whether intact faunal remains occurred in the consolidated sediment

below the cover sands, and also to determine if there was an identifiable archaeological or stratigraphic surface on which such remains occurred, a total of forty 1 m x 1 m units were excavated, some of which began as cover skim units within the contiguous block. These excavations were conducted in the NE quadrant ( $n = 33$ ) and the NW quadrant ( $n = 7$ ), near surface concentrations of artifacts and in areas thought to be less eroded. Excavation was done with shovels and trowels and, once below the cover sand, proceeded in arbitrary 10 cm levels. As before, all matrix was screened through 0.125 cm (1/8 inch) mesh. These excavation units, on average, reached depths of ~65 cm below surface, but in only one area did excavations encounter relatively large and complete bison elements.

Finally, in order to better understand the stratigraphic history of the site, bucket augering took place in 37 locations. Two auger holes were placed in Localities 1 and 3, but the remainder were within Locality 2, and more specifically within the NE quadrant. In addition, several profiles were cleared along the margins of the blowout, and an approximately 12 m long stratigraphic trench was hand dug through the center of the NE quadrant. Once

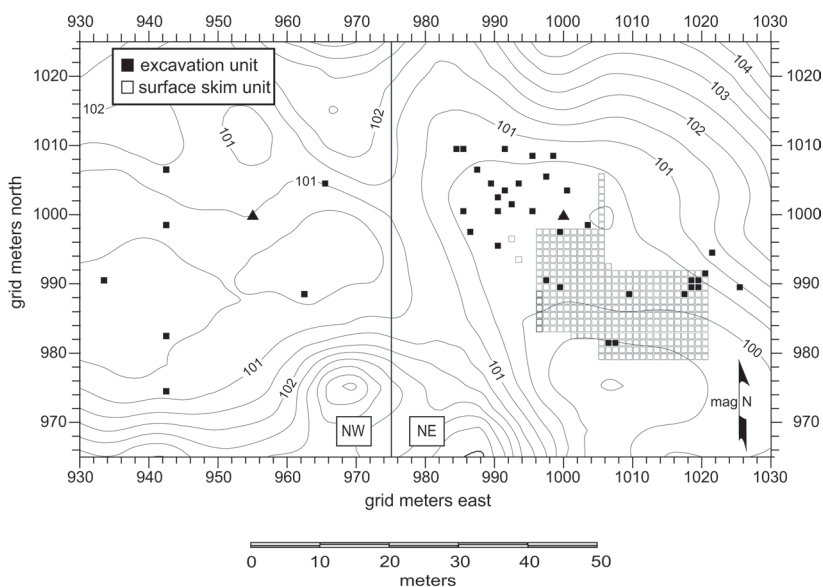


Figure 4. Surface skim and excavation units, NW and NE quadrants of Locality 2.

the coarse stratigraphic outline was assessed, the augering focused on determining the extent of a horizontally discontinuous soil, designated in the field as the "Tubb Soil," likely the same one that Rose previously identified as yielding the Paleoindian material, and might therefore represent a Late Glacial age archaeological soil and/or surface.

### **SURFACE AND COVER SKIM DATA AND DISTRIBUTIONS**

The surface-collected lithic and faunal remains are not distributed evenly across Locality 2 (Table 1a–c). Examining the tallies of bone and stone artifacts in Table 1a using G scores (a contingency table statistic similar to chi-square, but more robust) shows there is a statistically significant difference in their distribution by quadrant ( $G = 543.94$ ,  $df = 3$ ,  $p = 0.000$ ). Freeman-Tukey deviates, which are centered on zero and identify cell values significantly larger or smaller ( $\pm$ ) than would be expected by the null hypothesis, further refine that result. These reveal that faunal remains are significantly over-represented in the NE quadrant and significantly under-represented in the other three quadrants, while the opposite is true of the lithic remains (Table 1a). In non-statistical terms, the distribution of bone is not random across Locality 2 but is concentrated within the NE quadrant.

Looking more specifically at the lithic artifacts (Table 1b), and dividing those into five broad classes, reveals again a non-random distributional pattern across Locality 2 ( $G = 34.84$ ,  $df = 12$ ,  $p = 0.000$ ). In this instance, however, only a few cells within the contingency table have statistically significant Freeman-Tukey deviates: formal and informal tools are significantly over-represented in the NW quadrant. Caliche cobbles and burned caliche are significantly under-represented in the SW quadrant, yet significantly over-represented in the SE quadrant. If one assumes, as noted, that use of caliche for hearth stones generally post-dates the Paleoindian period, that would suggest a later component was localized within the SE quadrant.

Examining only the distribution of the 29 formal and informal chipped stone tools (Table 1c), and dividing that group into those that are Folsom in age (three projectile points, but excluding the

channel flake recovered in the surface collection), as opposed to those that are not temporally diagnostic, does not reveal a statistically significant difference overall in their distribution ( $G = 6.4$ ,  $df = 3$ ,  $p = 0.094$ ). Nonetheless, the Freeman-Tukey deviates indicate there is a significant over-representation of Folsom diagnostic artifacts in the NE quadrant.

A similar pattern emerges in regard to the faunal remains (Table 2a), which, as noted, occur in disproportionate numbers in the NE quadrant. Owing to the fragmentation of the bone, the great majority of these remains are not identifiable to taxa, though that too varies significantly by quadrant ( $G = 25.903$ ,  $df = 3$ ,  $p = 0.003$ ). However, a number of bone elements, primarily from the two northern quadrants ( $n = 59$ , of a total of 63), were identified as bison. The Freeman-Tukey deviates indicate that the bison bone is significantly under-represented in the SW quadrant (Table 2), and significantly over-represented in the NE quadrant. It is our impression, which unfortunately cannot be quantified, that many of the unidentifiable bones in the NE quadrant are large mammal bones, presumably from bison.

Although there was no systematic scan of the fauna for non-bison remains, several other taxa were observed. These mostly occurred as a relatively small number of isolated elements and probably represent a natural 'background' fauna not clearly related to human activity on site. These fauna were scattered throughout the site and included small carnivores (one of which was a canid), lagomorphs, rodents, a probable javelina, and turtle. It is again our impression that the non-bison taxa tend to occur primarily in the SW and SE quadrants, although if this is a natural 'background' fauna there is no particular reason why it should be so restricted.

Taken together, the observations that (1) the great majority of the surface collected artifacts and bison bones in Locality 2 were found in the NE quadrant; which (2) also yielded all of the diagnostic Folsom artifacts and nearly all of the identifiable bison remains (along with many unidentifiable remains large enough to be bison); and, (3) which was also the area where such remains were found when the site was first exposed in 1984 (Richard Rose, personal communication 2001), all

Table 1. Distribution by quadrant of surface collected items, Hot Tubb Locality 2.

**a. Faunal versus lithic remains from Locality 2, by quadrant**

Observed frequencies	Quadrant				Total
	SW	SE	NW	NE	
Bone	115	57	10	731	<b>913</b>
Lithic	485	244	53	334	<b>1116</b>
<b>Total</b>	<b>600</b>	<b>301</b>	<b>63</b>	<b>1065</b>	<b>2029</b>

## Freeman-Tukey deviates\*

	Quadrant				
	SW	SE	NW	NE	
Bone	<b>-11.38</b>	<b>-8.13</b>	<b>-4.22</b>	<b>10.30</b>	
Lithic	<b>7.72</b>	<b>5.52</b>	<b>2.81</b>	<b>-11.84</b>	

\* **all** cell values are significant at  $p = .05$  [ $\pm 1.200$ ]**b. Lithic remains from Locality 2, by general class and by quadrant**

Observed frequencies	Quadrant				Total
	SW	SE	NW	NE	
Flakes and debitage	431	200	42	280	<b>953</b>
Production debris (cores, channel flakes)	17	6	4	12	<b>39</b>
Caliche cobbles, Fire-cracked rock	23	29	1	23	<b>76</b>
Formal and informal chipped stone tools	9	3	6	11	<b>29</b>
Ground stone tools	5	6	0	8	<b>19</b>
<b>Total</b>	<b>485</b>	<b>244</b>	<b>53</b>	<b>334</b>	<b>1116</b>

## Freeman-Tukey deviates\*

	Quadrant				
	SW	SE	NW	NE	
Flakes and debitage	0.83	-0.57	-0.45	-0.30	
Production debris (cores, channel flakes)	0.07	-0.83	1.34	0.16	
Caliche cobbles, Fire-cracked rock	<b>-1.84</b>	<b>2.65</b>	-1.51	0.10	
Formal and informal chipped stone tools	-1.01	-1.40	<b>2.54</b>	0.80	
Ground stone tools	-1.15	0.90	-1.15	0.96	

\* only cell values in bold are significant at  $p = .05$  [ $\pm 1.518$ ]**c. Formal/informal chipped stone tools from Locality 2, non-diagnostic and Folsom, by quadrant**

Observed frequencies	Quadrant				Total
	SW	SE	NW	NE	
Non-diagnostic chipped stone tools	9	3	6	8	<b>26</b>
Folsom projectile points	0	0	0	3	<b>3</b>
<b>Total</b>	<b>9</b>	<b>3</b>	<b>6</b>	<b>11</b>	<b>29</b>

## Freeman-Tukey deviates\*

	Quadrant				
	SW	SE	NW	NE	
Non-diagnostic chipped stone tools	0.39	0.30	0.35	-0.53	
Folsom projectile points	-1.17	-0.50	-0.87	<b>1.38</b>	

\* only cell values in bold are significant at  $p = .05$  [ $\pm 1.200$ ]

point strongly to the Folsom occupation at Hot Tubb being localized in the NE quadrant of Locality 2. Much of the subsequent discussion focuses

on this quadrant, following brief comments on the other three for the sake of completeness.

In the SW quadrant there is a large concentra-



Table 2. Distribution by quadrant of surface collected identifiable and non-identifiable faunal remains from Hot Tubb Locality 2.

Observed frequencies	Quadrant				Total
	SW	SE	NW	NE	
Identifiable <i>Bison</i> elements	0	3	4	55	62
Unidentifiable elements	115	54	6	676	851
Total	115	57	10	731	913
Freeman-Tukey deviates*					
	SW	SE	NW	NE	
Identifiable <i>Bison</i> elements	<b>-4.68</b>	-0.33	<b>2.31</b>	0.77	
Unidentifiable elements	0.76	0.15	-1.09	-0.20	

\* only cell values in bold are significant at  $p = .05$  [ $\pm 1.200$ ]

tion of material ( $n = 603$ ), the great majority of which ( $> 80$  percent) are lithic artifacts with little or no large mammal bone. As can be seen in Figure 2, most of the specimens were found toward the western head of the entrant into the deflation basin. The artifact inventory is dominated by flakes and debitage ( $n = 431$ ), although this area also yielded five scrapers, several utilized flakes, and three of the four bipolar pebble cores found on the site. No Paleoindian diagnostic artifacts were found in this quadrant

The SE quadrant yielded half as many items ( $n = 298$ ), most of which were mapped and collected within the several deep blowouts in this quadrant, presumably where they had accumulated during deflation episodes. The majority of the artifacts ( $n = 200$ ) were nondescript flakes, but also found in this area were three small exhausted cores, and three biface fragments, one of which may be a Midland point preform (discussed below). Otherwise, no diagnostic Paleoindian artifacts or significant numbers of faunal remains were recovered. No additional fieldwork beyond the surface mapping and collection was conducted in either the SW or SE quadrants.

The NW quadrant produced only a very small amount of surface material ( $n = 60$ ). Save for two scrapers that resemble forms occasionally found in Paleoindian assemblages but are not diagnostic of this period, this quadrant was otherwise devoid of Paleoindian or Folsom remains. However, because those scrapers were present, limited test excavations were conducted here.

The artifact and faunal remains on the surface of the NE quadrant were generally distributed in a

northwest-southeast trending ellipse south of our primary site datum (HTA), broadly conforming to the northeastern edge of the deflation basin (Figure 5). Although these remains were on the floor of the deflation basin, they were not concentrated in the deep blowouts on that floor, suggesting that there has not been wholesale movement of material across that surface.

Nonetheless, there are unmistakable signs that the wind is potentially a factor in moving material on the surface, as evidenced by a scatter of small flakes extending 5 m up the face of the active dune on the northeastern edge of the basin (Figure 2). In addition, very small flakes occasionally line the ridge tops of active dunes downwind of the blowouts. In general, however, the archaeological remains that are thus entrained by aeolian processes tend to be small ( $< 1$  cm) and very light, suggesting that average wind velocities are insufficient to move larger remains. Occasionally strong gusts can occur: in June 2002, one of the 5 gallon plastic excavation buckets was lifted and carried ~20 m laterally, and then ~4 m up the dune face. But these are rare events and, judging by the distribution of archaeological remains, do not appear to have had a significant impact on the archaeological record (buckets, of course, also catch the wind and sail better than, say, large bison bone). Despite the aeolian taphonomic overprint, it is possible to detect traces of spatially distinctive loci within the site, as will be discussed.

Given the density and distribution of surface material in the NE quadrant, apparent after the first season of survey at Hot Tubb, surface skims were concentrated in this quadrant (Figure 4). Those

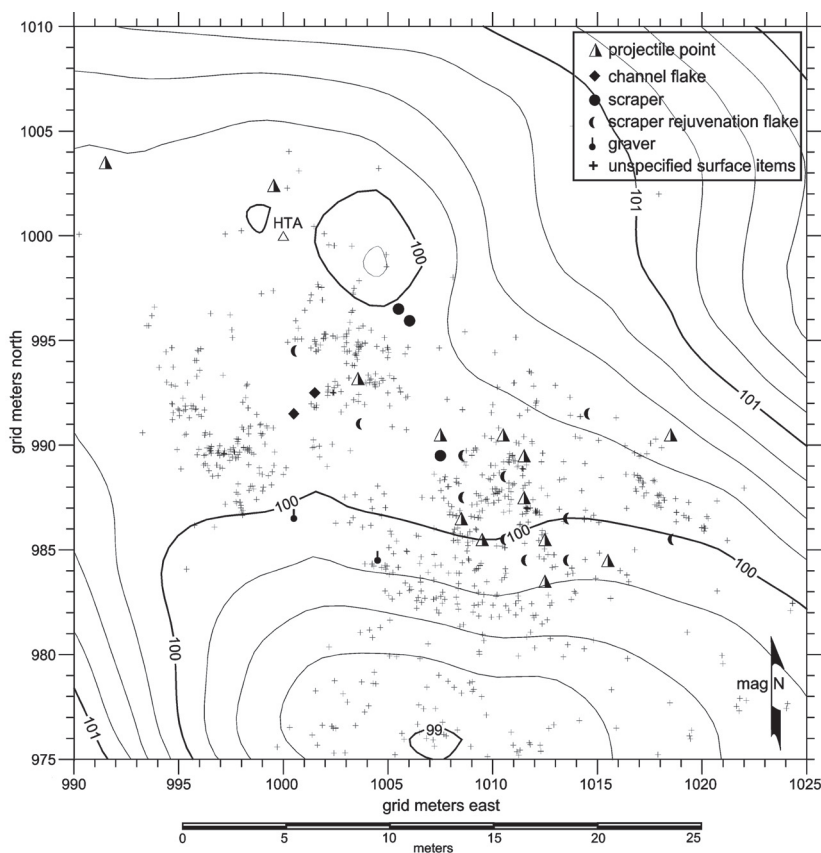


Figure 5. Close-up of NE quadrant Locality 2 showing mapped surface items, including diagnostic projectile points and identifiable tools and artifacts.

skim units yielded a total of roughly 18,750 lithic artifacts — the vast majority of which were small, non-diagnostic flakes and debitage — and approximately 55,800 g (~122 lb) of bones and bone fragments, slightly under 1 percent of which (501 g) was burned (given the highly fragmented condition of the bones, mass is a more meaningful measure than the number of fragments).

The distribution of the bone and lithics within the contiguous surface skim block is shown in Figure 6 (as relative density, in grams for comparability), superimposed against the surface topography. Several spatial patterns are apparent: first, these remains are not distributed uniformly across the surface but instead are concentrated in certain areas. The units containing greater amounts of bone generally overlap with those having greater amounts of lithic remains. The overlap is not per-

fect, however, and there is no numerical correlation between the mass of bone and lithics, by unit ( $r^2 = .181$ ). Equally apparent is the lack of correspondence between the density of material and the surface topography. Although the southernmost cover skim units extended down slope, material is not concentrated on those slopes or in the topographic low spots. There are several clear concentrations of lithic remains on the higher and flatter areas of the blowout floor.

In regard to the potential influence of the topography or wind on these distributions, the concentrations of lithic material are not obviously size-sorted. The mean weight of lithic specimens north and south of the N987 grid line, the approximate

point at which the slope breaks, is not significantly different, as measured by *t*-test. Insignificant results also obtain for the faunal remains. Although there may be, in some absolute sense, a greater amount of bone south of that line, it is not appreciably heavier than the remains north of the line, suggesting that the greater amounts of bone may lie close to where they originally were deposited (here assumed to be during Folsom times) and first exposed, and that lighter specimens were not moved appreciably by the wind or other taphonomic processes.

The observed spatial patterns of bone and artifacts do not appear to be random, but there is also no direct evidence these remains are in primary context or even the result of discernable cultural activities. That said, the distribution of burned bone is highly localized in an area of ~16 m<sup>2</sup> (Figure 6),

and where the greatest surface concentration of bone was spotted in 1984 (Richard Rose, personal communication 2001). This cluster of burned bone could be a cultural signature, perhaps an area where roasting was taking place. Corroborating that possibility is the discovery of a burned 'ear' of a Folsom point from one of the excavation units (N990 E1019) in this area, which also yielded large and intact bison remains. Yet, the concentration of burned bone may also be due to a natural fire at some point in the site's history. Not all of the bone surfaces are burned equally, and as Buikstra and Swegle (1989) argue this may be a signature of natural fire, or at least burning after some bones have dried and fractured.

In 1984 it was observed that the bison bones were eroding out of the northern wall of the deepest portion of the blowout in the NE quadrant, as though erosion was encroaching on a bonebed. Our data certainly support that supposition, though as noted below it is not clear that a large and intact bonebed is or was present at the site, at least in recent times. Nonetheless, it is certainly possible one was present in Folsom times, for the artifact record clearly indicates a human presence and an apparent bison kill.

### FOLSOM AND MIDLAND ARTIFACTS

A total of 50 prepared or otherwise utilized chipped stone tools (Table 3) were recovered from the surface and in the cover skims in the NE quadrant. These are combined in this discussion since the remains on the surface

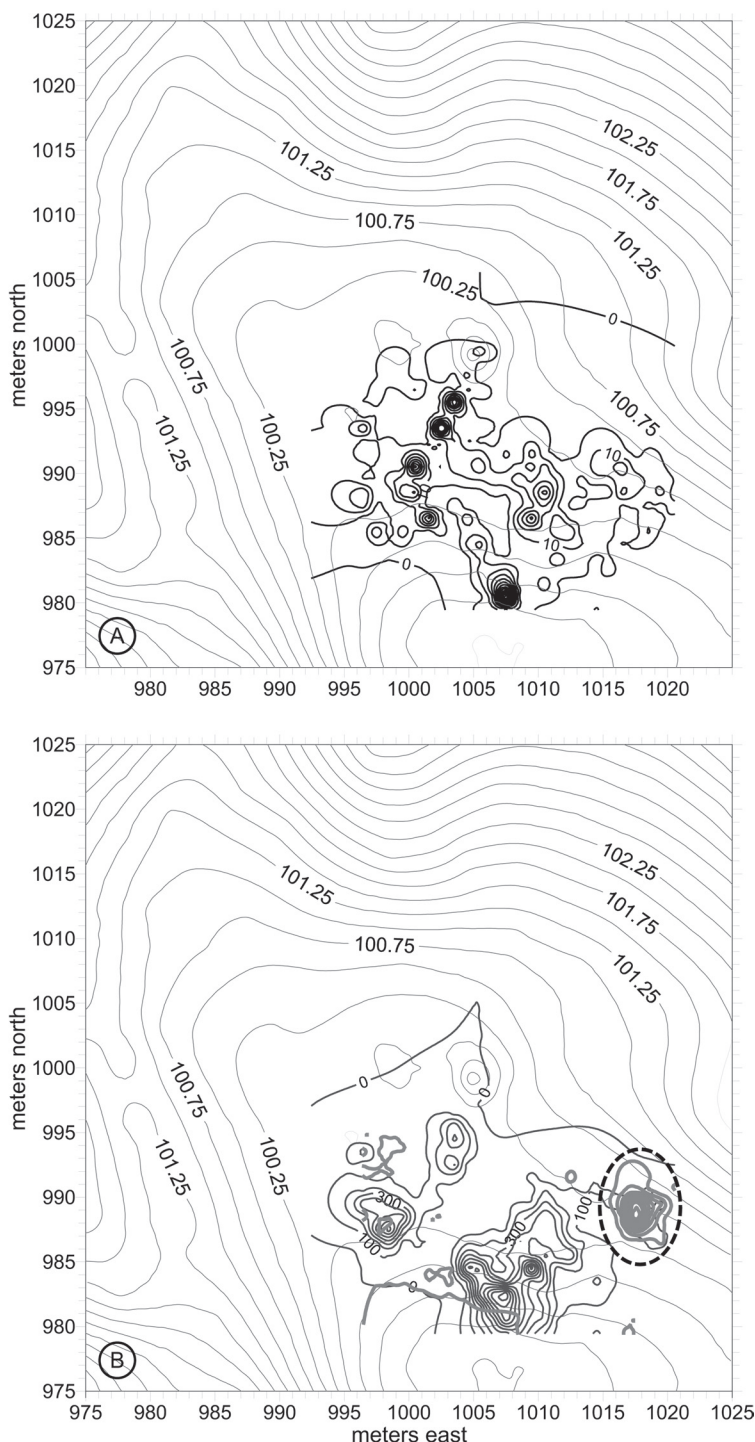


Figure 6. Density contour maps of (A) artifacts and (B) faunal remains in NE quadrant Locality 2, superimposed on surface contours (lighter lines). Oval in (B) indicates main concentration of burned bone.

and in the cover sand are arguably part of the same stratigraphic unit. These artifacts include bifaces, cores, and scrapers, none of which are clearly attributable to a cultural period, as well as thirteen projectile points and point fragments. The latter group is comprised of three Folsom point bases, a Midland point base, six Folsom point ears (Figure 7a–d), and three non-diagnostic point tips.

As all of the Folsom point bases have intact ears/corners, those six ears represent, minimally, an additional three points. Yet, given the variation in raw material type, size and shape of those ears, they could readily be from six different projectile points. Therefore, a minimum of six and a maximum of nine Folsom points were recovered during the 2002–2003 fieldwork at Hot Tubb. At least seven additional Folsom points were found here by collectors on earlier visits. Therefore, some 13–16 Folsom points have come from the surface of the site, along with at least one Midland point.

The three non-diagnostic projectile point tips recovered from the site cannot be refit to any of the recovered bases. One of those tips appears to have suffered impact damage. Such damage can occur whenever stone meets bone at high velocity (Frison 1991:177). Impact-fractured tips are common in Folsom assemblages, but are not diagnostic of Folsom, as they are also common in other Paleoindian and later assemblages (e.g. Bement

Table 3. Tool classes recovered from the surface and cover skims in the NE quadrant, Hot Tubb Locality 2.

Tool class	Number
Bifaces	5
Cores (includes one bipolar core)	7
Channel flakes	3
Gravers	2
Projectile points and point fragments	13
Retouched flakes	4
Scrapers	5
Scraper rejuvenation flakes	11
Total	50

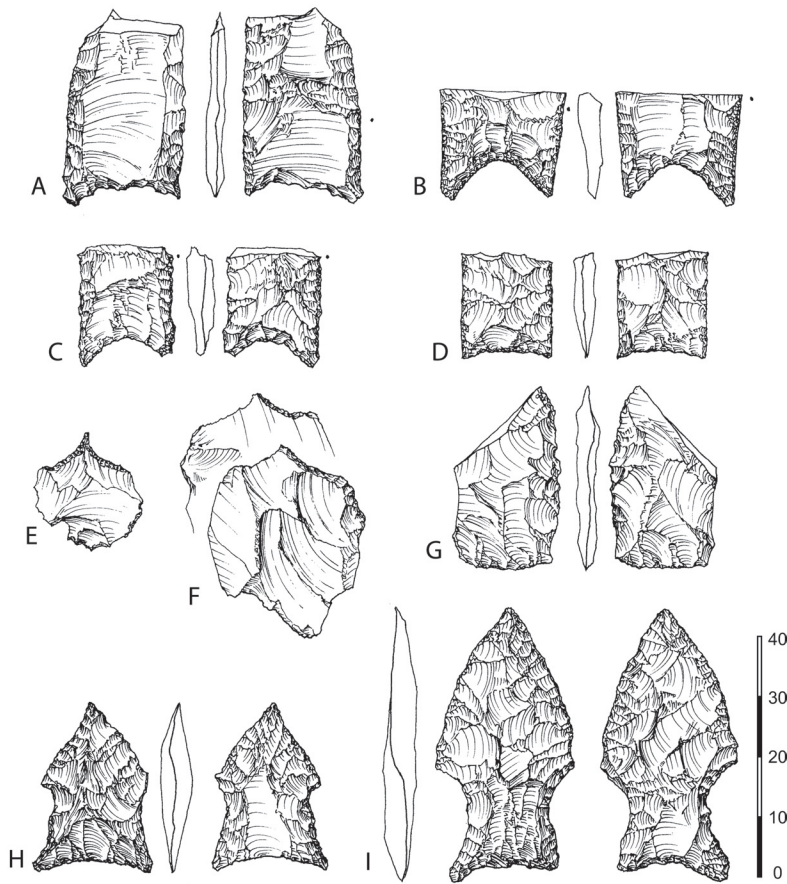


Figure 7. Line drawings of select projectile points and tools recovered from NE quadrant Locality 2. A, Specimen S895, Folsom point; B, Specimen HTA, unfluted Folsom point; C, Specimen O22-9, Folsom point; D, Specimen S2266, Midland point; E, single-spur graver; F, double-spur graver; G, Specimen S730, possible Midland preform; H, Wilson point; I, Pandale (Uvalde?) point. (Illustration by K. Monigal).



1999; Bradley 1982; Bradley and Frison 1987; Frison 1974, 1991; Frison and Bradley 1980; Frison and Stanford 1982; Meltzer 2006; Root 2000; Wheat 1979).

The projectile points and point fragments recovered from the site are made on at least two varieties of Edwards formation chert: one is a glassy tan or brown and the other an opaque dark gray. Those varieties could come from a single, variegated outcrop. That Edwards chert was used in the manufacture of the majority of the projectile point assemblage is not surprising, given the relative proximity of this source to the site. But relative proximity does not imply a short absolute distance. The nearest Edwards chert source matching the Hot Tubb projectile points would be around Sterling City, Texas, approximately 160 km to the east. This outcrop is also a likely source for the Paleoindian assemblage at the Shifting Sands site (Hofman et al. 1990). This is not the sole stone source used at the Hot Tubb site, however. Other tool classes are made from different varieties of Edwards chert, but these are not diagnostic to a particular time period.

Metric data and descriptions for the reasonably complete projectile points are provided in Table 4. As is common in Folsom assemblages that occur some distance from their stone source, those projectile points show considerable attrition. All three of the specimens in which a portion of the blade is still present (Specimens 7B2.6, 7B2.7, and S895) show evidence of re-sharpening and reworking:

- Specimen 7B2.6 is complete, but has been reworked down to its minimum effective slug size; most points are jettisoned at lengths of ~32 mm (Meltzer 2006; see also Jodry 1999). This point may have then been used for other purposes for it retains a small, sharp, graver-like tip.
- Specimen 7B2.7 had broken, presumably during use. After it broke, the remaining portion of the blade was trimmed in order to re-haft and re-use the specimen, and this involved re-fluting on the reverse face, which retains a portion of the original flute scar. Once the point was re-fit for use, it was subsequently re-worked.

- Specimen S895 (Figure 7a) is missing its tip, likely as a result of impact damage, for the specimen shows an impact ‘flute’ scar on the reverse face. Prior to this last episode of use and discard, the point had broken, and the remaining portion of the blade trimmed in order to re-haft and reuse the specimen. Like specimen 7B2.7, it also appears as though this process involved re-fluting on the obverse face, although the prior (original) flute is not obvious. Once re-hafted, the point was subsequently reworked.

All three of these specimens easily fall within the range of the Folsom type. That these points were re-used is hardly unusual for a Folsom assemblage. However, that two of them were broken blade segments that were re-fluted and then re-hafted is a somewhat unusual occurrence (Collins 1999). When those points originally broke, the blade must have still been long enough (or at least longer than the basal segment) that it could be pressed into service. Doing so required only the modification necessary to insure its lower portion would fit into the existing haft. As studies have shown, Folsom bases are highly standardized, indicating points were made to fit hafts, and not vice versa (Judge 1973; Meltzer 2006).

The rest of the projectile point specimens are base segments (Figure 7b–d). Specimen HTA (Figure 7b) appears to have snapped laterally within the haft, as the edge grinding extends the full length of each side. The point is classically Folsom in morphology with long projecting ears, and though it is doubly fluted on one side, it lacks evidence of fluting on the obverse face. Specimen O22-9 (Figure 7c) is ground on only a small and slightly projecting portion of its right edge, suggesting that it had been used, broke, and then was released from its haft. Given the slightly ragged nature of the remainder of the right and left edges, it would appear this specimen was used or otherwise damaged along its edges once it was released. Finally, S2266 (Figure 7d), another base, is not fluted, nor are there indications it ever was. The point shows fine pressure flaking, lateral thinning, and basal form characteristic of the Midland type, and is similar to specimens from the type site (e.g. Wendorf et al. 1955:Figure 12.4), which is located ~70 km east/

Table 4. Metric data on select projectile points recovered from Hot Tubb Locality 2.

Measurement	Specimen					
	7B2.6 (Rose)	7B2.7 (Rose)	Surface 895	Surface 2266	Surface – HTA	Skim Unit O22-9
Maximum length	34.60	40.78	32.60*	17.38*	18.57*	20.03*
Maximum width	24.32	24.28	20.39	15.31	21.71	16.27
Maximum width to base	15.6	2.02	19.01	0	18.57	9.54
Basal width	22.02	24.13	20.08	15.31	19.55	16.80
Maximum thickness	4.20	4.24	3.67	4.29	4.18	4.82
Maximum thickness to base	10.88	25.07	19.64	16.97	18.24	15.16
Flute thickness	2.78	4.10	3.45	0	3.60	3.33
Basal concavity depth	1.72	1.41	2.57	1.35	6.47	4.15
Number flutes –obverse	1	1	1	0	0	0
Flute length –obverse	23.08	29.29	25.81	na	na	na
Flute width –obverse	13.34	13.35	14.12	na	na	na
Number flutes – reverse	1	2	1	0	2	2
Flute length –reverse	26.43	23.62	12.75	na	11.74	9.45
Flute width –reverse	15.65	14.66	15.60	na	13.52	9.90
Edge grinding –left	18.28	23.48	14.32	17.29	18.56	0
Edge grinding –right	19.87	19.11	16.02	16.07	17.22	4.57
Reworked?	yes	yes	yes	na	na	na
Impact fracture?	no	no	yes	na	na	na

\* incomplete specimen: length-related measurements do not reflect the original size of the specimen.

Specimen number	Description
1.	7B2.6 (Rose) The point is complete, but has been heavily reworked, almost down to the minimal effective slug size. The point may have then been used for other purposes, for it retains a small, sharp graver-like tip. Folsom type.
2.	7B2.7 (Rose) The point is complete but had at one time broken, presumably during use. After it broke, the remaining portion of the blade was trimmed in order to re-haft and re-use the specimen (as was also the case with Surface specimen 895), and this involved re-fluting on the reverse face, which retains a portion of the original flute scar. Once the point was re-fit for use, it was subsequently re-worked. Folsom type.
3.	Surface 895 The point is missing its tip, likely as a result of impact damage, for the specimen shows an impact ‘flute’ scar on the reverse face (Figure 7a). Prior to this last episode of use and discard, the point had broken, and the remaining portion of the blade trimmed in order to re-haft and re-use the specimen. Like specimen 7B2.7, it also appears as though this process involved re-fluting on one face (obverse), although the prior, original flute is not obvious). Once re-hafted, the point was re-worked in the haft. Folsom type.
4.	Surface – HTA Point base only (Figure 7b). The point appears to have snapped laterally within the haft, as the edge grinding extends the full length of each side. The point is classically Folsom in morphology with long projecting ears, yet it lacks evidence of fluting on the obverse face, and would be classified an ‘unfluted Folsom.’
5.	Skim Unit O22-9 Point base only (Figure 7c). Only a small and slightly projecting portion of the right edge of this specimen is ground, suggesting that it had been used, broke, and was released from its haft. Given the slightly ragged nature of the remainder of the right and on the left edges, this specimen was used or otherwise damaged along its edges, once it was released from its haft. Folsom type.
6.	Surface 2266 Point base only (Figure 7d). The specimen is not fluted, nor are there indications it ever was. The point shows fine pressure flaking, lateral thinning, and basal form characteristic of the Midland type.

northeast of Hot Tubb.

Having a mix of Folsom and Midland points on one site is common enough on the southern High Plains. Localities with that combination of forms include Carley-Archer (Carley 1987), Mustang Springs (Meltzer and Collins 1987), the Scharbauer/Midland type site (Wendorf et al. 1955), Shifting Sands (Hofman et al. 1990), and Wyche Ranch (Holliday 1997). Indeed, sites with just Midland but no Folsom points are quite rare, Winkler-1 being the only known occurrence (Blaine 1968).

All of the projectile points just described were finished specimens that broke in use. None were broken in manufacture. Nonetheless, there is evidence Folsom point manufacture took place here, for several channel flakes ( $n = 3$ ) were also recovered. These might have been derived from the refuting of point blades broken in use, rather than fluting of biface preforms brought into the site. This indication of the refurbishment of weaponry is consistent with the occurrence of the Folsom point ears, which likely came out when the binding hafts were unwrapped to allow hafting of the newly fashioned replacements.

Two other artifact classes, although not obviously Folsom in age, are nonetheless intriguing and may be related to this occupation. Two graters were recovered from this area of the site (Figure 5). One is a small, single-spur flake grater or borer (Figure 7e). Although common in Paleoindian sites (e.g. Frison and Stanford 1982), tools of this type are not unique to Folsom assemblages. However, the other specimen (Figure 7f) is what Tomenchuk and Storck (1997) term a “double-scribe compass grater.” Similar tools have been found in a variety of Paleoindian sites, including some of Folsom age, notably Hanson, Lindenmeier, and the Folsom component at Agate Basin (Tomenchuk and Storck 1997:Table 2). Tomenchuk and Storck argue this type of grater is, in fact, broadly diagnostic of Paleoindian bone-working technology (Tomenchuk and Storck 1997:520).

Nearly a dozen end scraper rejuvenation flakes ( $n = 11$ ) have been recovered from the NE quadrant, all in a relatively circumscribed area (Figure 5). These flakes are formed by burin blows struck at the corner of the trimmed edge of a uniface, removing the dulled working bit and thus preparing

the scraper for additional use (for a detailed discussion, see Shafer 1970). These forms are also not unique to Folsom lithic tool kits (e.g. Frison 1968), though they are part of the Lindenmeier assemblage (Wilmsen and Roberts 1978:Figure 92). These re-sharpening byproducts, indicative of intensive use and recycling of dulled scrapers on site, are certainly consistent with the general dearth of raw material.

Neither of these tool classes can be directly attributed to the Folsom component on site, save on the basis of their spatial association. The Folsom and Midland projectile points and point fragments, as well as the channel flakes, graters, and scraper rejuvenation flakes (Figure 5), all clustered within a relatively small area of the NE quadrant. They were also generally associated with the areas of densest bison bone. That co-occurrence does not make these remains the same age; it leaves the matter an open question that must be resolved with additional data.

The distribution of the points, tools, and bison bone does not fall out in any obvious spatial patterns or activity areas — such as a kill area as opposed to a processing area — and, given the active surface of the site, skepticism would be in order if it did. That said, it is reasonable to argue this cluster of artifacts and bone appears to be non-random, and not simply the result of natural taphonomic processes that ‘gathered’ these remains in one large concentration.

#### **A Note on a Possible Midland Point Preform**

Roughly 30 m due south of this concentration of Folsom/Midland material, in the SE quadrant, an unusual biface fragment (Figure 7g) was recovered on the surface. The specimen (S730) is relatively small and thin, bi-convex in cross-section, with a maximum length of 30.03 mm, a maximum width of 19.07, and a maximum thickness of 4.82 mm. It is made of Edwards formation chert, has a slight waxy luster suggestive of heat treatment, and tiny red speckle inclusions characteristic of the Edwards formation chert that outcrops near Big Springs, Texas (Frederick and Ringstaff 1994), roughly 150 km (straight-line distance) northeast of Hot Tubb. This stone appears in Paleoindian assemblages elsewhere, including ones of Folsom,

Midland, and Clovis age, though its use was not restricted to tool kits of this antiquity. Although no precise counts were made, the red speckle chert is not uncommon among the pieces of debitage from the surface.

The piece is split along two axes: longitudinally, perhaps as a result of a burin-type blow (the broken edge has slight ripple marks, indicating force originating on the distal end of the biface), and then by a transverse hinge fracture across the blade, which removed the distal portion of the 'burinated' edge. There is a small section (~5 mm) of the upper right corner of the blade (Figure 7g, left) with edge wear or damage, possibly indicating the specimen, once broken, was briefly used.

Neither the slightly excurvate base nor the intact edge are trimmed uniformly. There is no evidence of fine pressure flaking or grinding. The flake scars range from 4.5–5.5 mm in width and include several basal thinning flakes on each face. Assuming the original specimen was symmetrical in thickness and width, the piece was likely on the order of 26–28 mm wide prior to breaking. No estimate can be made of its pre-break length.

In morphology and size (especially thickness) the specimen appears to be a projectile point preform, but of what type? There are no traces of prior flute removals, neither the base nor the edges were set up for fluting (e.g. Frison and Bradley 1980; Root et al. 2000), and with a thickness of less than 5 mm the specimen is already approaching the thickness of the average Folsom point (Amick 1995; Meltzer 2006). The specimen is not a Folsom preform.

Could it be a Midland point preform? None have ever been reported. However, if the arguments of Hofman (1992) are correct and these points are the product of stone-poor groups utilizing flake blanks of diminished size or perhaps recycled Folsom points or other tools, then Midland preforms *ought* to be relatively rare. That is, if stone was at a premium, then a Midland point broken in production would likely have been pressed into service for other tasks, assuming the specimen was large enough for use. If Midland points were made on the recycled portions of other tools, then early stage Midland preforms could also be difficult to identify, as they might display attributes of other tools as well. A specimen discarded 'in the act' of

being transformed from a Folsom to a Midland point, for example, might show remnants of flute scars, traces of edge or basal grinding, or a slightly concave base from prior fluting. None of these features are apparent on specimen S730.

Alternatively, if Midland points were made from small flake blanks, as Hofman (1992) also suggests, then one would still expect to see a range (albeit narrow) of successive forms and modifications which, in the stages immediately prior to completion, would likely be manifest as a specimen, like S730, that is laterally and basally thinned, relatively symmetrical in plan and cross section, but which lacks fine marginal retouch or edge grinding. However, it should also be noted that S730 also does not display the regular, co-medial, high-quality flaking often evident on finished Midland points, lacks beveling preparatory for pressure flaking, and, of course, cannot be spatially tied to the Folsom and Midland component at Hot Tubb, recovered as it was downslope in a secondary surface concentration (though wind, runoff, or animal movements could have transported it there). Specimen S730 thus remains only a possible Midland preform, not necessarily a probable one, for indeed it could date to a later period.

### THE HOT TUBB FAUNAL REMAINS

The majority of bones recovered from the site are highly fragmented, presumably due to active sand movement and trampling by grazing animals. As such, a strong relationship between element or fragment size and identifiability is apparent. Data in Table 5, derived from a random sample of 10 test excavation units, show that identifiable elements are significantly under-represented when fragments are less than 2 cm in size and significantly overrepresented at larger sizes ( $G = 207.30$ ,  $df = 3$ ,  $p = 0.00$ ).

Of course, *identifiability* is difficult to define, let alone quantify, and varies between researchers. We adopted a conservative approach and tallied as bison only those bones most readily recognized as such.

Summary faunal data are reported in terms of landmark MNEs (see Hill 2001) in Table 6 to indicate those features found to be most identifiable, or those most often preserved, given the suite of taphonomic processes that have shaped the Hot



Table 5. Bone element or fragment identifiability versus size class in a sample of bones from Hot Tubb Locality 2 (Freeman-Tukey deviates in parentheses).

	Size Class (in cm)			
	0-2	2-4	4-6	6-8
Unidentifiable elements	15302 (0.26)	762 (-0.79)	29 <b>(-1.65)</b>	0
Identifiable as bison	3 <b>(-8.16)</b>	24 <b>(7.03)</b>	10 <b>(5.31)</b>	0

\* only Freeman-Tukey values in bold are significant at  $p = .05$  (+/- 1.200)

Tubb archaeofaunal record. Reported MNE data represent the most frequent (e.g. highest MAU) landmarks for each particular element. Large mammal bones that could be identified to element or element group (e.g. vertebrae and metapodials), but not as bison per se, are largely comprised of small long bone fragments, rib blade fragments, vertebral body and neural arch fragments, cranial fragments, tooth fragments, and metapodial distal condyle fragments.

Given that the vast majority of the tens of thousands of fragmentary bones from Hot Tubb are less than 2 cm in size (e.g. 99.7 percent from a 10-unit sample), this significantly limits what can be derived from the faunal remains, especially in regard to element frequency. However, 360 bison specimens (NISP) are identified, representing six individuals (MNI), based on fused 2<sup>nd</sup> and 3<sup>rd</sup> tarsal counts (Table 6). There is insufficient data to resolve the season of their deaths — or even if their deaths co-occur.

On the basis of a few of the identifiable specimens, however, it is possible to ascertain the taxonomic identity of the bison at the site. Measurements of a complete bison radius were compared to published data of known bison from a number of archaeological sites of varying ages (Byerly and Seebach 2004): Bonfire Shelter Bone Bed 2 (Dibble and Lorrain 1968) and Lipscomb, Texas (Todd et al. 1992), both Late Glacial Paleoindian faunal assemblages; the Early Holocene (Cody complex) Horner site, Wyoming (Todd 1987a, b), and unpublished data from the Kaplan-Hoover site in Colorado, a Late Archaic (Yonkee) assemblage (S. Potter, personal communication 2003; Todd et al. 2001). Data on Historic period bison from Mus-

tang Springs, Texas, were also used (Byerly, unpublished). These comparative data indicate that the Hot Tubb radius falls within the range of *Bison antiquus* bulls from both Lipscomb and Horner (Byerly and Seebach 2004). Although all of the recovered bison remains from Hot Tubb cannot be assigned as such, it is probable that the bison bone concentration represents the remains of *Bison antiquus* and is therefore Late Glacial in age.

Aspects of the taphonomic history of this assemblage can be discerned from the condition of the bones. The only faunal elements to survive intact were caudals, 4<sup>th</sup> carpals, accessory carpals, 5<sup>th</sup> metacarpals, patellae, lateral malleoli, fused 2<sup>nd</sup> and 3<sup>rd</sup> tarsals, 1<sup>st</sup> tarsals, 2<sup>nd</sup> metatarsals, proximal and distal sesamoids, and dew claws (Table 6). That these particular elements are preserved and often complete is likely due to their density and size. In regard to the former, there is a significant positive correlation ( $r_s = .56$ ,  $p = .00$ ) between bison element frequencies (%MAU) and volume density (VD), indicating that density-mediated attrition (Lyman 1994) influenced bison bone survival. Further, under conditions in which taphonomic processes mechanically fragment bone (animal trampling, compression forces, etc.), smaller, compact elements are the likeliest to survive intact and be identified (Lyman 1994). It might also be the case, as Conard and Kandel (2004) argue, that the unique architecture of certain bone elements, such as teeth and vertebrae, are better able to withstand fluctuations in moisture and temperature, and thus better able to survive weathering and erosion. However, we have not determined if those bones recovered as complete elements at Hot Tubb have such architecture.

The majority of the bone surfaces examined are severely eroded, abraded, and polished. The broken edges often have a “melted” appearance, and much of the identifiable cortical surface is etched, pitted, polished and/or smeared. A detailed examination of cortical surface modifications of the Hot Tubb bone was not conducted, but fine scratches and deep incisions are observable on some elements. These are attributes Brain (1967) observed in bone recovered from trampled assemblages in sand matrices around waterholes (also Lyman 1994:381).

Importantly, in terms of a possible cultural sig-

Table 6. Bison bone elements recovered from Hot Tubb Locality 2.

EL	Element	Landmark	NISP <sup>1</sup>	(L)MNE <sup>2</sup>	MAU	%MAU	VD <sup>3</sup>
MR	mandible	coronoid process	7	2	1.0	16.7	0.79
AT	atlas	left caudal articular facet	1	1	1.0	16.7	0.34
AX	axis	centrum	3	1	1.0	16.7	0.38
CE	cervical (3-7)	caudal articular process	19	6	1.2	20.0	0.62
TH	thoracic (1-14)	centrum	24	1	0.1	1.2	0.42
RB	rib	head	17	15	0.5	8.9	0.27
LM	lumbar (1-5)	caudal articular process	17	5	1.0	16.7	0.11
SC	scapula	glenoid cavity	4	3	1.5	25.0	0.50
HM	humerus	lateral condyle	12	2	1.0	16.7	0.38
RD	radius	lateral glenoid cavity	9	3	1.5	25.0	0.48
CPU	ulnar carpal		3	2	1.0	16.7	0.43
CPI	intermediate carpal		9	5	2.5	41.7	0.35
CPR	radial carpal		5	4	2.0	33.3	0.42
CPF	4 <sup>th</sup> carpal		4	3	1.5	25.0	0.44
CPS	2 <sup>nd</sup> carpal		6	5	2.5	41.7	0.50
CPA	accessory carpal		4	4	2.0	33.3	
MC	metacarpal	CPF facet	12	4	2.0	33.3	0.59
MCF	5 <sup>th</sup> metacarpal		5	5	2.5	41.7	0.62
IM	innominate	acetabulum	8	3	1.5	25.0	0.53
FM	femur	minor trochanter	12	2	1.0	16.7	0.34
PT	patella		3	3	1.5	25.0	
TA	tibia	medial groove	12	4	2.0	33.3	0.41
AS	astragalus		20	5	2.5	41.7	0.72
CL	calcaneus	LTM facet	10	4	2.0	33.3	0.66
LTM	lateral malleolus		5	4	2.0	33.3	0.56
TRF	1 <sup>st</sup> tarsal		3	3	1.5	25.0	
TRS	fused 2 <sup>nd</sup> & 3 <sup>rd</sup> tarsal		12	12	6.0	100.0	0.52
TRC	fused central & 4 <sup>th</sup> tarsal		15	7	3.5	58.3	0.77
MT	metatarsal	TRC facet	8	3	1.5	25.0	0.52
MTS	2 <sup>nd</sup> metatarsal		6	6	3.0	50.0	
PHF	1 <sup>st</sup> phalanx	distal	22	10	1.3	20.8	0.48
PHS	2 <sup>nd</sup> phalanx	distal	18	5	0.6	10.4	0.46
PHT	3 <sup>rd</sup> phalanx	medial	10	1	0.1	2.1	0.32
SEP	proximal sesamoid		45	45	2.8	46.9	
SED	distal sesamoid		18	16	2.0	33.3	

<sup>1</sup> NISP data **do not** represent just those landmarks specified, they include **all** identified specimens per element. MNE, MAU, and %MAU data reflect **only** specified element landmarks.

<sup>2</sup> (L)MNE = Landmark MNE (see Hill 2001:30-31).

<sup>3</sup> VD = Volume Density (data from Hill 2001:Appendix 2; derived from Kreutzer 1992, 1996).

nature, no identified specimens retain unambiguous evidence of cutmarks or impact fractures (see Lyman 1994). No fresh fractured bone was identified. Given the generally poor condition of the bones, this negative evidence cannot rule out a human agency in the accumulation of this fauna, but it does mean that additional data and more detailed analysis would be necessary to identify possible human butchery activities at Hot Tubb.

Because the assemblage is comprised primarily of distal limb elements, and lacks indications of other elements that may have once been deposited, it is uncertain whether this was a primary kill

locality, and/or one where secondary processing of bison carcasses took place. That said, it is reasonable to argue the high frequency of low utility elements (e.g. feet), along with the few recognized cranial and axial fragments, do not preclude the possibility this locality was where the kill occurred (assuming those are not transported 'riders' — see Binford 1978; Cannon 2003; Hill 2001).

It is possible that additional, more complete faunal remains may occur at the site. Four excavation units were placed in the area that yielded the discrete concentration of burned bone found on the surface and in the cover skims (Figure 6). Those

excavation units — put in the last few days of the 2003 field season — produced a relatively large volume of bone, much of it burned, which occurred as larger fragments and a few complete elements. Excavation did not continue below this bone concentration, or into the deeper dune to the east. This concentration may represent the last remaining, relatively intact, remnant of the Folsom-aged occupation at the site. Very little faunal material was recovered from the surface units above those remains, although the surface density of material remains is not necessarily a reliable indicator of subsurface density, as discussed below.

### STRATIGRAPHY AND THE SUB-SURFACE ARCHAEOLOGICAL DATA

Early on in the augering and testing, it was apparent there were remnants of a buried soil on site. This unit, the Tubb Soil, is a buried A horizon (Ab), medium to fine sand in texture, and ranges in color from grayish brown (10YR 5/2), to brown (10YR 5/3), to pale brown (10YR 6/3). It lacks evidence of strong pedogenesis, there are no peds or clay coatings, and the unit is structure-less (massive), non-calcareous, and non-plastic in consistence. Stratigraphically, it varies in thickness from 5 to nearly 50 cm. Much of that variation is likely attributable to erosion and bioturbation. In some areas the upper surface of the Tubb Soil is heavily sculpted or blown out altogether. Even where it appears to be relatively intact, in our northernmost excavation units, the upper and lower surfaces are somewhat irregular, partly from erosion (above) and bioturbation — by insects and rodents — throughout the unit and below.

The Tubb Soil marks a period when increased precipitation supported vegetation growth in what may have been, judging by the underlying sands, an interdunal depression. The time of soil formation was likely relatively brief, based on its weak development, light color, and lack of well-defined structure (common features of A horizons in the sandy soils of this region [Holliday 2001]). The Tubb Soil was buried, in turn, by the consolidated sands, which are cross-bedded in places, suggesting aeolian processes were the primary depositional agent.

Based on our augering and excavations, the Tubb Soil is patchily distributed in the NE quad-

rant, with the largest contiguous area forming an oval approximately 18 m x 20 m, located north of our N1000 grid line (Figure 8). The Tubb Soil is relatively thicker and its upper surface is nearly level in the test units located on an east-west line through that area, but the surface of the Tubb slopes down and thins considerably in the test units located on a north-south line. The Tubb Soil is close to the surface in some parts of the NE quadrant and buried as much as 80 cm below the surface in other parts; generally, it is more deeply buried in the northernmost units closest to the dune margins. Beyond that, the Tubb Soil appears in smaller patches or is absent altogether. For a variety of reasons, it is likely that its distribution in the past was more extensive than at present, at least within the NE quadrant.

As earlier stated, the artifacts Rose observed in the early 1980s appeared to be associated with what we now recognize as the Tubb Soil. Likewise, much of the archaeological material recovered from our excavations was stratigraphically associated with this unit. Figure 9a plots the overall vertical distribution of artifact density (measured by mass) relative to the position of the Tubb Soil for 18 excavation units in which the Tubb Soil occurs. Because the absolute elevation of the Tubb Soil varies, the excavation level in which the Tubb Soil was encountered within each unit is set to 0, with the levels above (+10 cm, +20 cm, +30 cm etc.) and below (-10 cm, -20 cm, -30 cm, etc.) designated accordingly. The average level of the surface in those 18 test units (~30 cm above the Tubb Soil) is shown for the sake of discussion and comparison.

Figure 9a shows that artifact densities are low in the consolidated sands overlying the Tubb Soil, sharply increase and peak in abundance in the excavation level immediately atop and within the upper few centimeters of the Tubb Soil, then diminish sharply below it. On average across the Tubb Soil-bearing units, ~70 percent of artifacts came from the level in which the Tubb Soil was first encountered (as Figure 9a is a sum of all artifacts in the Tubb level divided by all artifacts, the 'area-wide' value is nearly 80 percent). In some units, nearly 95 percent of the artifacts recovered came from that level (e.g. N1006 E987, and N1009 E985). Excavation units with higher densities of

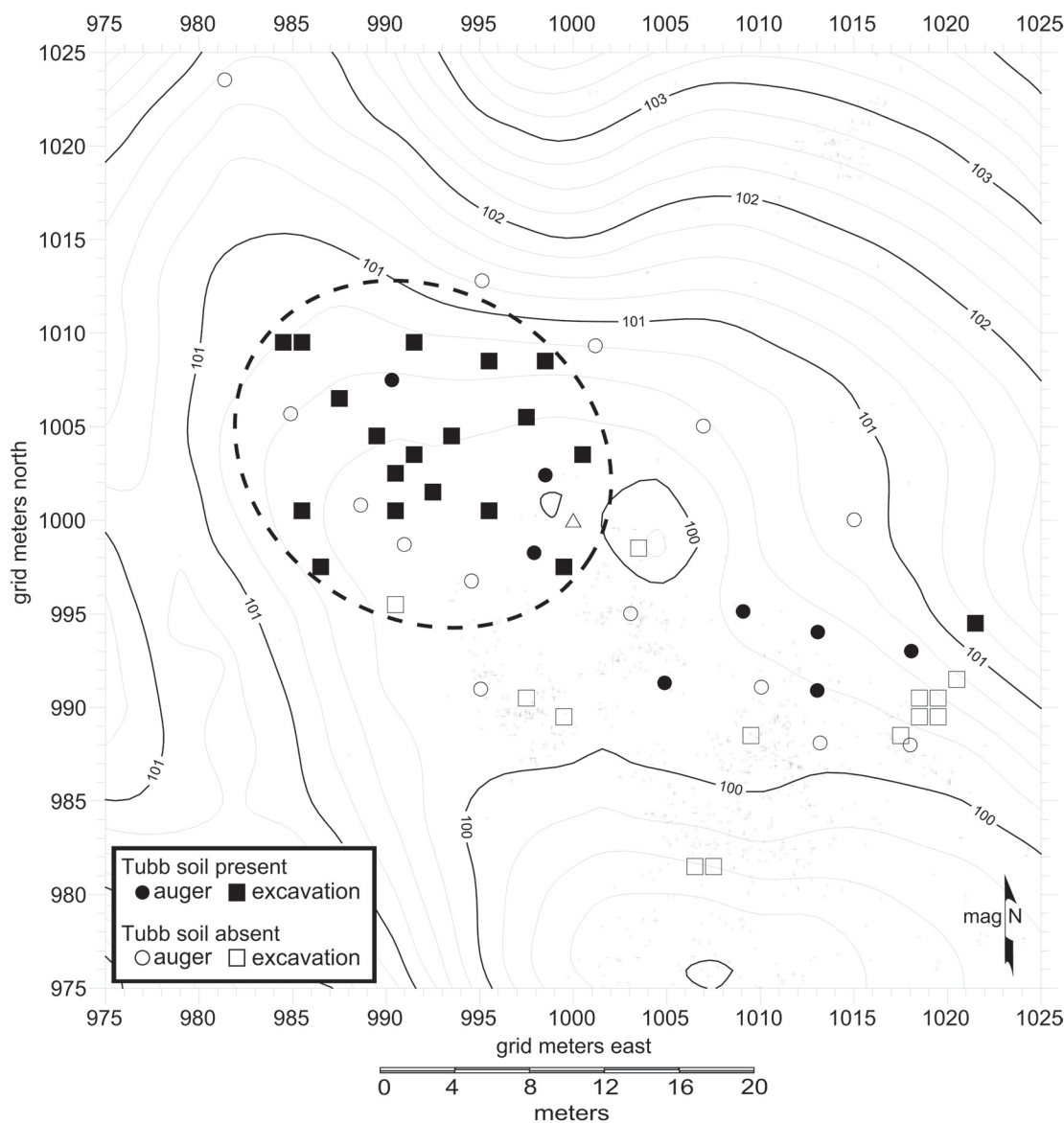


Figure 8. Location of auger holes and test excavation units in the NE quadrant Locality 2, in which the Tubb Soil is present (solid squares and circles) or absent (hollow squares and circles). Oval indicates approximate area of contiguous Tubb Soil.

artifacts do not appear to correlate with the depth that the Tubb Soil is presently buried, suggesting higher densities are not merely a function of better preservation beneath a thicker sand mantle. The few artifacts found deep within the Tubb Soil were likely brought there as a result of post-depositional mixing, given the extensive evidence of bioturbation.

The plot of artifact densities in excavation units placed in areas where the Tubb Soil was absent ( $n = 8$ ) is strikingly different (Figure 9b). In this plot, because the only common stratigraphic horizon is the surface, that level is set to 0, and artifact densities are plotted in 10 cm depths below it (e.g. -10 cm, -20 cm, -30 cm, etc.). As might be anticipated were the artifacts originally laying



on a distinctive stratigraphic horizon which had since deflated (the Tubb Soil), densities would not be expected to peak at any particular depth. Rather, they ought to be distributed irregularly throughout the profile, as a result of the vagaries of the movement of artifacts in sand. This is the pattern evident in Figure 9b. Indeed, the corresponding depth below surface where the Tubb Soil ought to be relative to the surface were it present in those units (e.g. -30 cm), has the *lowest* density of archaeological material.

Figure 9a provides compelling evidence that portions of the site's archaeological remains are indeed associated with a buried stratigraphic surface. By itself, the pattern in Figure 9b cannot be used to argue that the Tubb Soil was once present in those areas but has since deflated. However, the artifacts recovered in those units do provide compelling circumstantial evidence that deflation did, in fact, occur. The evidence comes in the form of the kinds of artifact classes found in units with Tubb Soil present, and those from units lacking the Tubb Soil. These data are shown in Table 7. Contingency table analysis comparing the frequency of tool classes in those units reveals that the two are not significantly different in their distribution ( $G = 8.35$ ,  $df = 7$ ,  $p = 0.302$ ). Indeed, only in the case of end scrapers is there a significant difference in the Freeman-Tukey deviates: more than would be expected by chance occur in the test units excavated in the areas where the Tubb Soil is absent. In effect, the very same kinds of tools are being recovered in both areas, indicating a homogeneity to the distribution of tools across this area of the site and, again, lending circumstantial support to (or at least not precluding) the possibility that those remains were part of the same depositional episode on the same surface (alternatively, different groups arrived on site at different times, but with the same repertoire of tools).

Similar contrasts appear in regard to the density of surface and subsurface material. In general, and this is quite apparent visually (Figure 8), the areas in which the Tubb Soil is present had very low densities of archaeological debris on the surface. In contrast, where the Tubb Soil is thin or absent, the surface is marked by the highest density of artifacts and faunal remains. Furthermore,

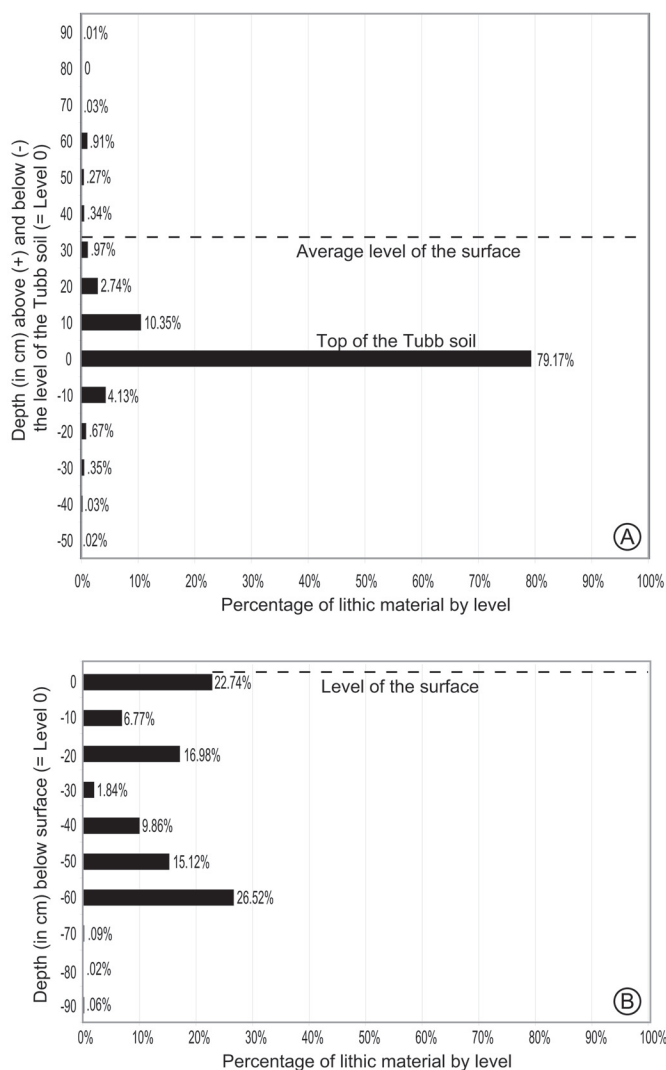


Figure 9. Plots of lithic material (in grams) by depth, from excavation units. (A) Units in which the Tubb Soil is present, with lithic artifact densities shown by 10 cm level above (+) or below (-) the position of the Tubb Soil (= Level 0). (B) Units in which the Tubb Soil is absent, with lithic artifact densities shown by 10 cm level below (-) the surface (= Level 0). Note the depth and frequency of artifacts relative to the surface in (A) and (B).

Table 7. Tool classes recovered from the excavation units where Tubb Soil was present or absent, NE quadrant, Hot Tubb Locality 2.

Tool class	Tubb Soil present	Tubb Soil absent	Total
Bifaces	1	0	1
Cores (includes one bipolar core)	3	0	3
Channel flakes	0	0	0
Gravers	1	0	1
Projectile points and point fragments	4	1	5
Retouched flakes	1	0	1
Scrapers	2	4	6
Scraper rejuvenation flakes	5	1	6
Total	17	6	23

a statistical comparison of the classes of artifacts found on the surface (including the cover skins), and those recovered in the test units (e.g. comparing the data in Table 3 and Table 7) shows no significant difference ( $G = 6.02$ ,  $df = 7$ ,  $p = 0.537$ ). What is being found on the surface is essentially identical to what is being found below the surface; they are only being found at different levels in different parts of the site.

Unfortunately, there are no obvious physical links or actual refits tying the excavated material from atop the Tubb Soil to artifacts recovered from either the surface or excavated units in areas where the Tubb Soil is absent. However, there was the burned Folsom ear recovered in association with the burned and unburned bison bone in an area where the Tubb Soil is absent. And the same red speckle chert from which the possible Midland preform was fashioned occurs in the form of two exhausted cores (from N1009 E991 and N1000 E990), and five scraper rejuvenation flakes like those found on the surface also occur in association with the Tubb Soil.

The inferences that might be drawn from these patterns are (1) the archaeological remains were at one time associated with the Tubb Soil, and (2) the Tubb Soil once extended farther south than it does now and was blown out — perhaps between the 1980s and the present — at which time the artifacts associated with it were ‘released’ and became part of the clastic fabric of the dune sand.

### The Age of the Tubb Soil

Merely because the artifacts appear to be

stratigraphically associated with the Tubb Soil does not make them contemporaneous with it, but it does raise the question: what is the absolute age of the Tubb Soil? Unfortunately, there are few clues to help answer that question. The soil does not contain sufficient organic material for radiocarbon dating. Some numerical age control is provided by two samples of sediment for OSL dating obtained by Stephen Stokes in 1989. These yielded ages of  $4.6 \pm 0.5$  ka years B.P., and  $13.4 \pm 2.1$  ka years B.P., corresponding to depths of 15 cm above and 30 cm below what Collins identified as the bonebed and what Stokes described as a discontinuous layer of flakes and burned bone (Stephen Stokes, personal communication 2003). These ages were derived using multiple-aliquot additive dose procedures; single aliquot procedures would likely yield finer-resolution ages (see Feathers et al. 2006). Nonetheless, these ages bracket the Folsom period which, in calibrated radiocarbon years (equivalent to OSL ages), ranges from 13.2 to 11.2 ka cal years B.P. (10,900 to 10,200  $^{14}\text{C}$  years B.P.).

To close that gap, we attempted to obtain an age on the bison bones, duly recognizing the bone may not be the same age as the Tubb Soil. Given our initial failure to obtain a radiocarbon age on the rib (noted above), eight additional bison bones were sent for dating: a petrous portion, four proximal sesamoids, two distal sesamoids, and the complete radius. In all cases, however, there was again insufficient organic material to yield a radiocarbon age (Paul Matheus, personal communication 2004).

The evidence in regard to the *relative* age of

the Tubb Soil is equally inconclusive. The site has obviously yielded Folsom and Midland projectile points, the remains of *Bison antiquus*, and some evidence linking the two. Even so, no diagnostic Folsom material was found on the Tubb surface or within it; the possible exception here is a heavily burned point midsection (N1004 E993) which, though unfluted and lacking a base, nonetheless preserves traces of grinding on one edge. This may be the remains of a Midland point, and it is atop the Tubb Soil surface.

A very worn and re-sharpened Wilson point (Bousman et al. 2002; Dial et al. 1998:376) was recovered from heavily bioturbated, consolidated sands immediately above the Tubb Soil in unit N1008 E995 (Figure 7h). Similarly, a Pandale point (or possibly a Uvalde point, which is of similar antiquity) was recovered — regrettably, in the screen — from an excavation level that straddled the gradual transition from the overlying consolidated sands into the Tubb Soil in unit N1000 E985 (Figure 7i). Neither of these points, the one Late Paleoindian, the other Early Archaic, provide definitive constraints on the age of the Tubb Soil, which could have developed earlier or later in time. For that matter, the fact that a couple of stray Folsom points were found on the overlying surface near these excavation units has no stratigraphic or chronological implications, given the demonstrated potential for movement of artifacts on that surface.

All of which raises three hypotheses in regard to the relative age of the Tubb Soil: (1) it post-dates the Folsom occupation; (2) it predates the Folsom occupation; or (3) it is contemporaneous with that occupation. We consider these in turn.

The first possibility seems least likely a priori, given that virtually no artifacts, even of later age, are found within the Tubb Soil. Such ought to occur, if the soil formed in place after the archaeological material was deposited.

The Tubb Soil could predate Folsom. It is almost certain this dune field was active at times in the past, and the Tubb Soil may have been a lag surface on to which components of various ages came to rest after the deflation of overlying deposits, or perhaps after having been moved through the overlying sands as a result of bioturbation, thereby forming a stone-line (e.g. Johnson and

Watson-Stegner 1990; Leigh 2001). The younger of the two OSL ages derived by Stokes supports the possibility that the basin deflated during Early to Middle Holocene times (Stephen Stokes, personal communication 2003). Further, there are later Paleoindian and Early Archaic projectile points close to the Tubb Soil surface. If the Tubb Soil is pre-Folsom, the association of archaeological materials with it (Figure 9a) would be fortuitous.

Finally, the Tubb Soil could mark a small interdunal pond or marshy area contemporary with Folsom. That would be within the range of the earlier of the two OSL ages. Were this a pond or marshy area, it would have attracted a bison herd and, in turn, Folsom hunters onto that surface, in which case the association of artifacts with it would not be fortuitous. The diagnostic artifacts from later components could then have lagged down to that surface. However attractive that scenario might be, there is neither archaeological nor chronological evidence to support it.

Until diagnostic Folsom artifacts are found on the Tubb Soil surface, it is impossible to say whether the association of the two is meaningful. Of course, even if such diagnostics are found, the association could still be fortuitous. What is more certain is that the Tubb Soil represents a geological unit which, where preserved, serves as a useful stratigraphic marker for cultural remains.

## SUMMARY AND CONCLUSIONS

Many results emerge from our research at Hot Tubb. First, and most obviously, this was evidently a locality in which Folsom hunters killed at least six *Bison antiquus*. This inference is based on the preponderance of heavily damaged projectile points (possibly 13–16), some with impact fractures and/or end shock (e.g. the high number of Folsom point ears); the mass of bison bone, which was both burned and unburned and included cranial, vertebral, and distal limb elements; and, the co-occurrence of a Folsom point fragment with bison bone in at least one excavation unit, albeit one in which the stratigraphic situation is complicated by the absence of the Tubb Soil.

Whether extensive processing of bison carcasses also took place here, in addition to initial field butchering for transport elsewhere, cannot be fully ascertained given the poor condition of the

bone elements. Nevertheless, there is evidence of intensive processing activities having taken place. Both surface collections and excavations yielded a number of scrapers ( $n = 11$ ) and, more telling, a larger number of scraper rejuvenation flakes ( $n = 17$ ). None of the rejuvenation flakes refit to any of the scrapers, suggesting a minimum number of 28 scrapers were used on site. Further, two gravers similar to those seen in other Paleoindian assemblages were also recovered.

All of these tools came from the same relatively small area of the Hot Tubb site that also produced bison bone and Folsom points. If associated, and attributing all of these artifact classes to the killing and processing of bison by a Folsom group is admittedly inferential, they indicate activities related to carcass and hide processing and narrow the time of occupation to within the span of the Folsom period, 10,900 to 10,200  $^{14}\text{C}$  years B.P. (well within the bracketing OSL ages).

Although we lack direct paleoenvironmental data from Hot Tubb, there is increasing evidence that the southern High Plains during this period was beset by episodic drought (Holliday 2000), interspersed by periods when the landscape was shrouded in  $\text{C}_4$  grassland (e.g. Connin et al. 1998; Koch et al. 2004; Meltzer 2005, 2006) sufficient to support herds of bison. Bison are not obligate  $\text{C}_4$  feeders but show preference for this forage in  $\text{C}_4$  dominated grasslands (e.g. Peden 1976; Peden et al. 1974).

The heavy use and attrition indicated by the lithic remains — the intensive re-sharpening and recycling of both scrapers and projectile points — bespeaks a group(s) for whom stone, by the time they arrived at Hot Tubb, was in short supply. Just how low the supply had dwindled can be seen in the size and mass of the available stone. The largest chipped stone artifact on site, a flake scraper, is less than 7 cm in maximum length and just under 60 grams in mass. There are 10 cores from the site, but all are exhausted. The relative paucity of stone does not mark only the known or suspected Folsom artifacts; the Wilson and Pandale points are both heavily re-worked (Figure 7h–i), and in other parts of Locality 2, as noted, several bipolar pebble cores, which could not have yielded much useable stone, were recovered.

The paucity of stone returns the discussion to

the Folsom/Midland question. Although the majority of the Paleoindian projectile points recovered here are of the Folsom type, there is a small Midland component as well. No Midland and Folsom points were recovered in a stratigraphic or archaeological context that shows the two forms were contemporaneous. Indeed, and as noted, one Midland base was found on the surface northwest of the main Folsom concentration, a possible Midland mid-section was recovered from atop the Tubb Soil, and the possible Midland preform was found in the SE quadrant, well south of the heavy concentration of Folsom points and bison bones. But if these remains are not contemporaneous, why at this site, as well as at more than half a dozen other sites on the southern Plains, are Midland and Folsom groups ending up at precisely the same localities? Winkler-1 is the sole exception to this pattern, and given that it too is a complicated sand dune site, there may be unrecorded evidence of Folsom at this locality.

Yet, despite the unambiguous evidence of stone being in short supply at Hot Tubb, this does not necessarily favor Hofman's (1992) argument that Midland points were manufactured by Folsom groups when stone for tool-making became rare or unavailable. After all, channel flakes indicative of Folsom point manufacture are present. More generally, in many parts of the geographic range of Folsom stone is scarce, and although such sites yield extensive re-working and recycling of lithic assemblages, few typical Midland forms are reported (Meltzer 2006). Similarly, Midland points ought not to occur in stone-rich areas, but they do (Collins 1999:26). The fact that Midland points are not widespread on the Plains generally, but instead have a relatively restricted geographic range and routinely co-occur with Folsom, suggests these points are indeed contemporaneous with and are a regional stylistic variant of Folsom.

The raw material used at Hot Tubb was dominantly Edwards chert, and given that only this source can be documented, it is difficult to ascertain the larger territory that might have been utilized (e.g. Jones et al. 2003). It is possible to surmise, however, that it was greater than the straight-line distance from stone source to site, which surely minimizes the actual distances traveled. Indeed, judging by the small size of the largest pieces re-



covered, and the intensive evidence for recycling, the groups who brought it here had not recently replenished their stone supply. Hot Tubb was occupied as this toolkit was nearing the end of its functional use life. Given that the stone had originally been collected from outcrops to the east of the site, it is tempting to speculate that this group was en route east and south back to that source area when it made the kill at Hot Tubb. But that speculation has little empirical support, save the fact that the group clearly knew where the source was and had relied on it previously.

Research at Hot Tubb has left a number of questions unanswered, such as the age of the Tubb Soil, its relationship to the artifacts resting on it, whether this site represents more than a primary kill locality, etc. Given the challenge of working with archaeological materials in an active sand dune, such are not unexpected, but it is useful to point out that by careful examination of the horizontal and vertical distribution of the remains, it is possible to tease out spatial and stratigraphic patterning in this dynamic geomorphic setting.

Some of those unanswered questions could perhaps be resolved if additional fieldwork were undertaken at the Hot Tubb site. There appear to be areas of the site in which additional intact archaeological deposits occur, 'intact' being something of a relative term. Although no further work is planned for Hot Tubb in the foreseeable future, sites such as this, despite the archaeological challenges and complexities they present, should continue to be documented to enhance our understanding of Folsom and Midland assemblages and adaptations in Late Glacial times.

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