

## GEOARCHAEOLOGY OF THE MIDLAND (PALEOINDIAN) SITE, TEXAS

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*In 1953 human remains and a new type of Paleoindian artifact were discovered eroding from a "blowout" in a small dune field along Monahans Draw, near Midland, Texas, on the Southern High Plains. The projectile points became the type "Midland" collection. Stratigraphy, radiometric dating, paleontology, and geochemistry suggested that the artifacts and bones dated to at least 10,000 B.P. and that the human remains were possibly as old as 20,000 B.P. The researchers believed that the human bones were from below a red sand that in turn was below a Folsom occupation. The dating of the human remains has long been problematic, however, and recent attempts to apply U-series dating further confuse the story. Geoarchaeological investigations were carried out at the site from 1989 to 1992 to reevaluate the geochronology, with particular reference to the age of the skeletal material. We reach several conclusions: (1) there are two Red Sands; (2) the human remains are from below the upper Red Sand, but the Folsom material is from above the lower Red Sand and, therefore, the Red Sand stratigraphy is not relevant to the age of the human remains; (3) the human remains were associated with the valley-margin facies of a lacustrine carbonate that is well dated in the region and rarely is > 10,000 B.P.; and (4) all numerical dating methods applied at the site produced unreliable results. We find no compelling evidence that the human remains from the Midland site are older than Folsom age; they may be contemporary with or younger than the Folsom occupation.*

*En 1953 restos humanos y un nuevo tipo de artefactos paleoindios fueron descubiertos en una superficie de deflación en un pequeño campo de dunas en Monahans Draw, cerca de Midland, Texas, en los Grandes Llanos del Sur. Las puntas de proyectil se conocerían como la colección tipo "Midland." La estratigrafía, los fechados radiométricos, la paleología, y la geoquímica sugirieron que los artefactos y huesos se remontaron a cuanto menos 10.000 a.P. y que los restos humanos posiblemente tuvieron una antigüedad de casi 20.000 a.P. Una pieza clave de evidencia fue la interpretación de que los restos humanos estaban localizados estratigráficamente bajo una capa de arena roja, la que a su vez se encontraba debajo de un sitio Folsom. Sin embargo, el fechado de los restos humanos ha sido problemático por largo tiempo; recientes intentos de emplear series de uranio (U-series) no han hecho sino complicar la historia. Investigaciones geoarqueológicas fueron llevadas a cabo en el sitio entre 1989 y 1992 a fin de reevaluar la geocronología, con particular atención a la edad del material óseo. Hemos llegado a varias conclusiones: (1) existen dos Arenas Rojas; (2) los restos humanos provienen de debajo de la capa de Arena Roja superior, pero el material Folsom se halla encima de la Arena Roja inferior y, por tanto, la estratigrafía de la Arena Roja no es relevante a la edad de los restos humanos; (3) los restos humanos han sido asociados con la facies del margen del valle de un carbonato lacustre ampliamente fechado en la región y que raramente es > 10.000 a.P.; y (4) todos los métodos de fechado numérico empleados en el sitio produjeron resultados poco confiables. No hemos hallado evidencia fehaciente de que los restos del sitio de Midland antecedan a la fase Folsom; quizás sean contemporáneos con, o más recientes que, la ocupación Folsom.*

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In 1953 Keith Glasscock found fragments of human bone and teeth from a 30-year-old female (Stewart 1955:90) eroding out of the dry channel of Monahans Draw. Subsequent archaeological investigations by Fred Wendorf and colleagues (1953–1955) and by E. H. Sellards (1954) in the draw and in the adjacent deflation basins—which together became known as the Midland (or Scharbauer) site—yielded considerable numbers of Paleoindian artifacts. Several

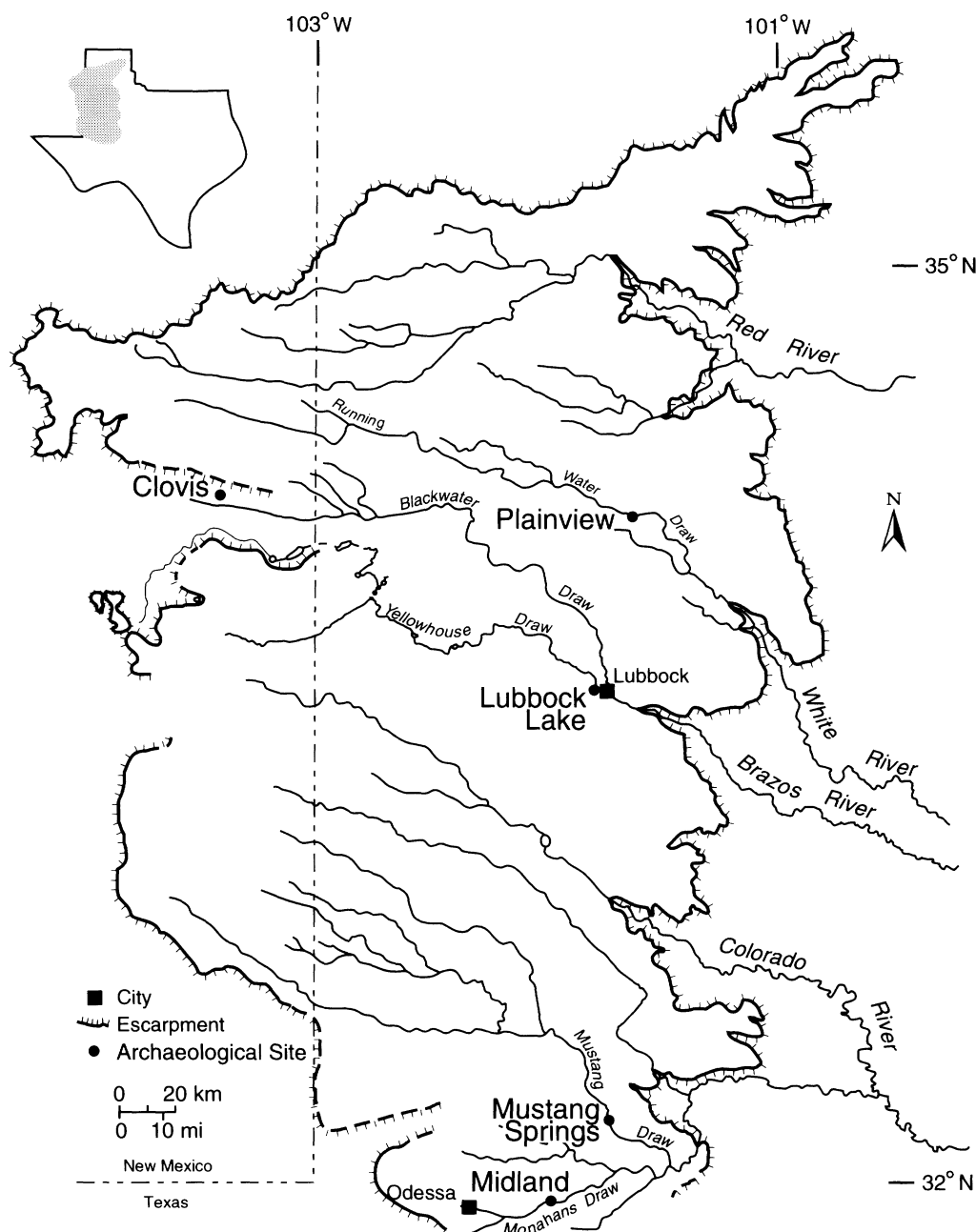
lines of evidence hinted that the human remains were Paleoindian as well.

Although pioneering for their time, and using many then-emerging dating techniques, these investigations were nonetheless unable to resolve the age of the Midland skeleton. However, the various investigators presented compelling evidence that the skeleton and artifacts were at least 10,000 years old, with the skeleton perhaps being significantly older—as much as 20,000 B.P.

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**Figure 1.** Map of the Southern High Plains showing all sites mentioned in the text, as well as selected physiographic features and cities. Inset shows the Southern High Plains in Texas.

(Wendorf and Krieger 1959:77–78). As such, the Midland skeleton became one of the first well-documented Paleoindian human remains in North America, was routinely cited in archaeological literature and textbooks (e.g., Jennings 1983:40,

1989:65–66; Krieger 1964; Wormington 1957), and to this day is still one of the handful of skeletons purportedly from this period and hence of vital interest to physical anthropologists and archaeologists (Steele and Powell 1992; Turner

1992). Furthermore, identification of a new artifact style—the Midland point—resulted in a long-running debate over Paleoindian typology and technology (e.g., Agogino 1969; Amick 1995; Frison et al. 1996:207; Judge 1970).

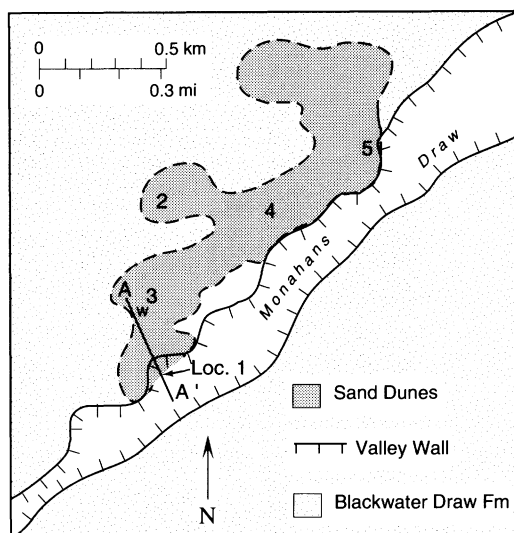
Questions about both the skeletal remains and artifacts are largely chronological problems. And these problems have been exacerbated through the years by the application of a variety of experimental or untested dating techniques. Given the knowledge gained from the various dating techniques since they were applied to the Midland discovery, and from the 40 years of additional geoarchaeological research in the region, a new look at the Midland site is in order.

As part of our own geoscientific and archaeological interests in the region, we worked at the Midland site from 1989 to 1992. Our goals were to: (1) document the site stratigraphy, particularly in the context of Holliday's regional investigation of the stratigraphy and paleoenvironmental record of the draws of the Southern High Plains (Holliday 1995a); (2) determine if any intact archaeological deposits remained; and (3) obtain samples for AMS radiocarbon dating or otherwise date the deposits. This paper presents the results of our study.

### Setting

The Midland site is on the Southern High Plains of northwestern Texas and eastern New Mexico (Figure 1), a relatively featureless plateau with a warm, semiarid, continental climate. The principal surficial deposit in the Midland area is the Blackwater Draw Formation, consisting of extensive layers of Pleistocene eolian deposits strongly modified by pedogenesis (Holliday 1989a). The flat High Plains surface is modified locally by dunes, easterly flowing dry valleys ("draws"), and by thousands of small "playa" basins containing seasonal lakes (Holliday 1995b).

As noted, the area of the Midland site that yielded the skull is along Monahans Draw (Figure 1), in a reach set within a small dune field that encroaches on the draw (Figures 2 and 3). This distinction, while critical, is rarely mentioned in discussions about the site, which put it entirely within a dune field, despite the explicit statement of Wendorf et al. (1955:13–15; see Haynes



**Figure 2.** General map of the Midland site showing the location of the dunes relative to Monahans Draw, Localities 1 to 5 ("w" indicates the location of section 3w at the west end of Locality 3; see also Tables 3 and 4b), and line of section A–A' (Figure 5) (modified from Holliday 1995a:Figure 24a).

1993:230; Jennings 1983:40, 1989:65; Kelley 1964:3–4; Smith 1976:125; Wormington 1957:242).

Monahans Draw (a tributary of the Colorado River system; Figure 1) is cut into the Blackwater Draw Formation and older units and contains late Pleistocene and Holocene alluvial, lacustrine, palustrine, and eolian sediments (Holliday 1995a). The draws of the region attracted human occupation, and some of the best-known Paleoindian sites are in such settings (e.g., Plainview, Clovis, and Lubbock Lake) (Sellards 1952; Wormington 1957).

The artifacts from the Midland site are scattered over the small (< 5 km<sup>2</sup>) dune field that rests on the Blackwater Draw Formation. Wendorf et al. (1955:Figure 2) identify five localities that make up the Midland site (Figure 2) and are in deflation basins or "blowouts" within the active portion of the dune field and, in the case of Locality 1 (where the skeletal remains were discovered), along the draw. At Locality 1, wind eroded through the dunes and into the valley fill. The other four localities are entirely within the dunes north of the draw (Figure 2). Our work focused primarily on Locality 1 and the west end



**Figure 3.** Locality 1 at the Midland site during the initial visit by Fred Wendorf and colleagues on October 29, 1953, looking north across the north end of the blowout. Figures in the centerground are near the spot where human remains were found (see Figure 5). (Courtesy of the Texas Memorial Museum, University of Texas, Austin)

of Locality 3 (3w). The latter was a key area for correlating the Paleoindian archaeology and dune stratigraphy with the human remains and draw stratigraphy. Some of the dunes on the margins of Locality 1 are still active; the draw portion itself is now heavily vegetated owing to a seasonally high water table (Figure 4) and sewage effluent pumped into Monahans Draw by the city of Odessa some 20 miles "upstream" of the site (Figure 1).

#### **Bones of Contention: 1953–1955 Investigations**

The first professional investigation of the Midland site occurred in 1950 during a paleontological survey by E. H. Sellards and Glen L. Evans of the Texas Memorial Museum, Austin, but no archaeological materials were observed (Wendorf et al. 1955:7). In June 1953 Keith Glasscock discovered the human remains as he was surface collecting artifacts in Locality 1 (Wendorf et al. 1955:15). Near the skeleton he also found several projectile points of apparent Paleoindian style, subsequently designated "Midland" points by Wendorf and Krieger

(1959:67). Glasscock contacted Fred Wendorf, then at the Laboratory of Anthropology in Santa Fe. Based on the degree of fossilization of the bone and the possible association with Paleoindian artifacts, Glasscock, Wendorf, and eight others met at the site on October 28, 1953, to examine the locality (Figure 3).

Surface collecting and a small test pit placed at the spot where the bones were first found yielded additional human bone along with fossils of other species, as well as more probable Paleoindian artifacts. In addition, Folsom artifacts were found in other blowouts, along with morphologically similar but unfluted projectile points—referred to early on as unfluted Folsom points (Wendorf et al. 1955:49). Three of those unfluted points, including one that would become the Midland point type specimen, came from Locality 1 (Wendorf et al. 1955:48). Glasscock originally supposed the skeletal remains and the points were associated; Wendorf and others tentatively concluded that they were not and that the points had eroded out of the overlying deposits (Wendorf and Krieger 1959:67; Wendorf et al. 1955:4, 45, 98).



Figure 4. Coring in Locality 1 at the Midland site on July 4, 1990. The view is northwest across the north end of the blowout. The Giddings rig is near the area where the human bone was recovered. The margins of the blowout have moved to the northwest and north since 1953. Note the heavy brush (largely salt cedar) around the margins of the basin. The vegetation and muddy floor are the result of dumping of tertiary sewage effluent into Monahans Draw by the city of Odessa, resulting in a high water table in the draw and regular flooding of the valley floor.

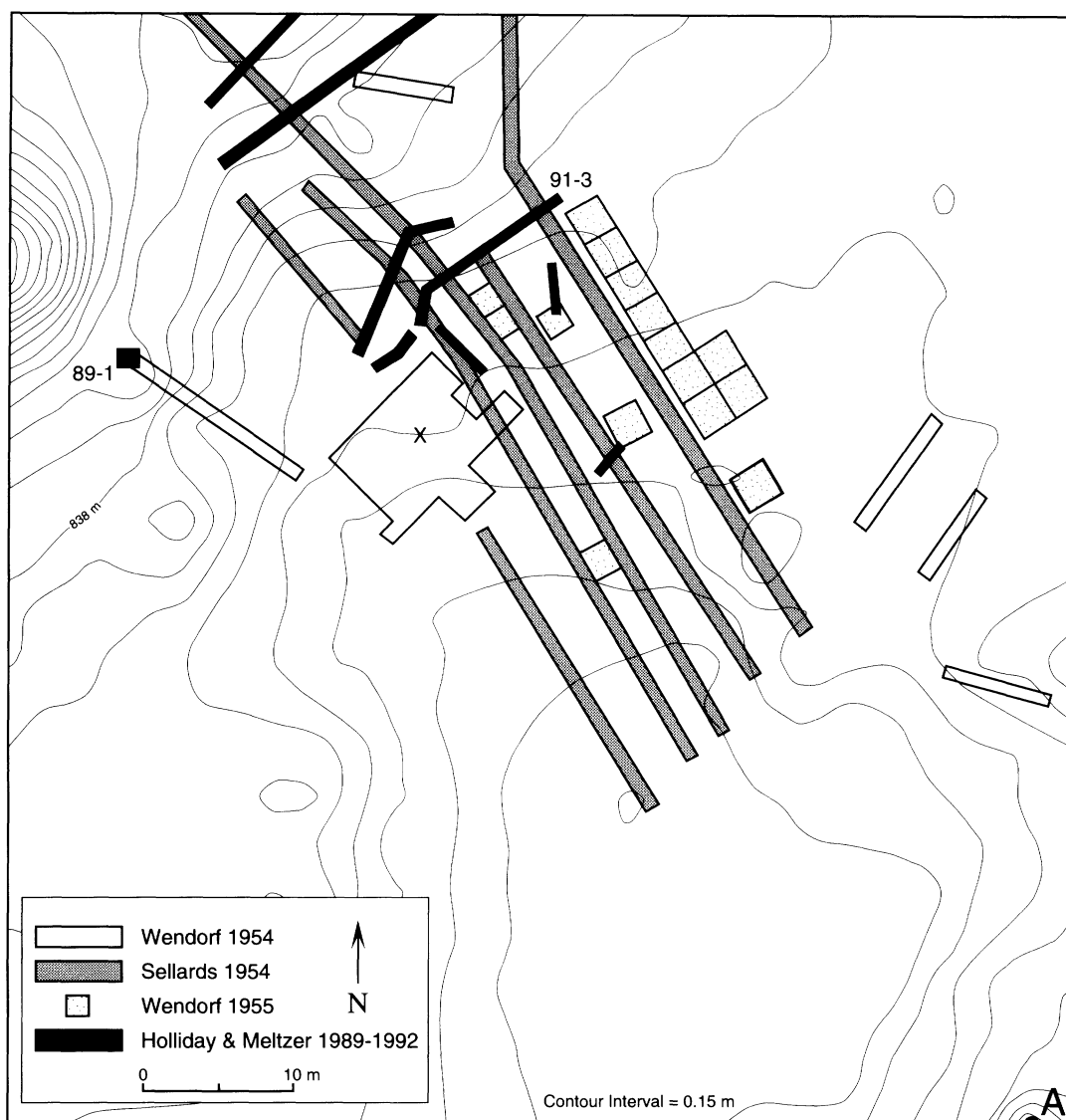
Stratigraphic relationships between Locality 1 and the other blowouts were unclear, but there were indications that the Folsom artifacts in the other localities came from a stratum that might overlie the one yielding the human remains (Wendorf et al. 1955:41–42).

The suggestion that the human remains were potentially of considerable antiquity, possibly older than Folsom, prompted three periods of field investigation in 1954 and 1955. Wendorf and a small crew spent February 1954 excavating in Locality 1 (Figure 5) in order to determine the stratigraphy, collect any age-specific fossils, and recover more of the human skeleton (Wendorf et al. 1955:42). This work and the 1953 finds are the focus of the volume produced by Wendorf et al. (1955). In November and December 1954, E. H. Sellards and a small crew machine trenched Locality 1 (Figure 5) looking for additional fossils and artifacts in the Paleoindian deposits (Sellards 1955). Wendorf returned to the site in October and November 1955 to search for more artifacts and reexamine the stratigraphy to resolve

questions regarding the age of the site (Figure 5) (Wendorf and Krieger 1959).

#### Stratigraphic Results of the 1953–1955 Investigations

The interpretations by Wendorf et al. (1955) and Wendorf and Krieger (1959), particularly regarding the age of the human remains, largely hinge on the site stratigraphy. Five strata, Units 1 to 5, oldest to youngest, were identified at the site (Table 1). The strata were grouped into two informal formations: Judkins (Units 1 to 3) and Monahans (Units 4 and 5). The three members of the Judkins formation were informally named the “White Sand” (Unit 1), the “Gray Sand” (Unit 2), and the “Red Sand” (Unit 3). The White Sand, a carbonate-cemented sand, produced abundant Pleistocene fossils, especially horse (*Equus* sp.), but also *Mammuthus columbi*, *Camelops* sp., *Canis dirus*, *Platygonus*, *Capromeryx*, *Bison antiquus*, and several species of small mammals. Also abundant in this unit were snails and clams, which indicated the White Sand was deposited in



**Figure 5.** Topographic map of the blowout in Locality 1 with the location of Wendorf's trenches and pits (1954 and 1955), Sellards's trenches (1954), Holliday-Meltzer trenches (89-1 and 91-3 refer to stratigraphic sections in Tables 3 and 4a), and datum A (lower right) established by Meltzer. The large irregularly shaped excavation area from Wendorf's 1954 excavations is the find-site of the human remains (x).

a small lake or sluggish stream (Wendorf and Krieger 1959:66; Wendorf et al. 1955:27, 67).

Resting disconformably on the irregular, eroded upper surface of the White Sand (Wendorf et al. 1955:29, 67) was the Gray Sand consisting of two discontinuous subunits: 2a (older) and 2b (younger). The two units in some places were superimposed; lower Unit 2a was distinctly

lighter in color than 2b, included reworked fragments of the White Sand, yet had neither artifacts nor fossil remains. The artifacts, a variety of faunal remains, some possibly reworked from the underlying White Sand, and the partial human skeleton were from Unit 2b, a grayer and more homogeneous deposit (Wendorf et al. 1955:29). The origins of the Gray Sand were unclear:

Albritton (in Wendorf et al. 1955:31) suggested it represented sand blowing into shallow lakes during a moist interval, while Wendorf and Krieger thought the Gray Sand might be material blown from the eroded surface of the White Sand and hence represented the “beginning of a prolonged dry period” (Wendorf et al. 1955:67–68).

Lying atop the eroded surface of the Gray Sand (and in places directly atop the White Sand) in Locality 1 was the Unit 3 Red Sand, a “cross-laminated” eolian deposit. This unit was recognized in the other localities where it was capped by a buried soil (Wendorf and Krieger 1959:66; Wendorf et al. 1955:32). Vertebrate remains, including horse, pronghorn, *Capromeryx*, deer or elk, turtle, and possibly mammoth, were recovered from the Red Sand (Sellards 1955:132; Wendorf et al. 1955:33, 97). The Red Sand evidently was deposited during a long period of aridity, which closed with a return “to more humid conditions” as evidenced by the buried soil (Wendorf et al. 1955:68).

Capping the section were Units 4 (light brown) and 5 (tan) sands of the Monahans formation, which represented, respectively, vegetated older dunes and younger active dunes. The sediment source for these dunes was thought to be the Unit 3 Red Sands, which were mobilized during periods of drought in the more recent past (Wendorf et al. 1955:34–35).

The White and Gray sands were found only in Locality 1, but the other three sand layers were found in all localities. The latter made it possible to link the various localities stratigraphically, and thus chronologically order the skeletal and artifact remains from the different areas.

The human remains were found on, and just beneath, the eroding surface of the Gray Sand as it was exposed by wind deflation (Wendorf et al. 1955:41). The skeletal material was believed associated with the Gray Sand and not the overlying Red Sand because (1) the original surface finds had gray sand adhering to them, and in the inner cavities; (2) additional fragments of human bone were found in situ in the Gray Sand; (3) there was no evidence of a pit; (4) the degree of fossilization of the human bone was similar to that of other bone from the Judkins formation, and (5) the human bones had fluorine content

Table 1. Correlation of Stratigraphic Terminology for the Midland Site.

Formation	Wendorf et al. 1955	This Paper
Monahans	Unit 5 Unit 4	Stratum 5s
Judkins		
Red Sand	Unit 3	Stratum 4s
Gray Calcareous Sand	Unit 2b Unit 2a	Stratum 3s2 Stratum 3s1
White Calcareous Sand	Unit 1	Stratum 1

From Holliday 1995a:Table 13a

“closely similar” to that of the other fossils from the White and Red sands (Wendorf and Krieger 1959:67; Wendorf et al. 1955:37, 40–41, 94–95, 120). The last point seemed to suggest either all the bones were derived from a source of the same age (the White Sand), or that the White, Gray, and Red sands were sufficiently close in age as to preclude differentiation by chemical analyses. Wendorf et al. (1955:94) favored the latter interpretation.

Stone artifacts were recovered from all five localities. Most were from surface collections, but some were recovered during excavation or were observed in place. At the end of the initial excavations it was assumed that the artifacts found in the Gray Sand in Locality 1, including several Midland points, flake scrapers and knives, debitage, grinding-stone fragments, and burned caliche, were not in primary context, but had probably “dropped to the gray sand by undercutting” of the overlying Red Sand (Wendorf et al. 1955:98, also 45–48). This assumption was made because of the high concentration of artifacts associated with the buried soil at the top of the Red Sand in Locality 1 and in the other localities on site. The alternative interpretation—that the artifacts and the distinctive (Midland) point style existed before, during, and after the formation of the Red Sands—seemed “hard to believe” (Wendorf et al. 1955:48).

In the 1955 excavations, however, two concentrations of burned rocks, two *Equus* teeth, and a point base were recovered from within the Gray Sand itself (Wendorf and Krieger 1959:10–71). Wendorf and Krieger viewed the artifact as having a bearing on the age of the Gray Sand. If it was a Midland point, its occurrence in the Gray

Sand "would be seriously out of [chronological] gear with the faunal correlation" and evidence from other localities (Wendorf and Krieger 1959:75). Hence, Wendorf and Krieger leaned toward the interpretation that this particular specimen in the Gray Sand was not a Midland point, but instead a small, Clovis-like but unfluted form (Wendorf and Krieger 1959:74–75).

The points and other artifacts found in the widely separated localities were thus correlated stratigraphically and chronologically by their position relative to the Red Sand (Wendorf et al. 1955:31–33, 52). Quite simply: since, in the dune localities (2–5), the fluted and unfluted Folsom points always occurred atop the Red Sand (Wendorf and Krieger 1959:67; Wendorf et al. 1955:69), and since the Midland points from Locality 1 were likely reworked from the Red Sand, this depositional unit became "a chronological reference point from which we may project backward to the deposits containing the human bones [the Gray Sand] and extinct animals [the White Sand below the Gray Sand, containing horse, camel, mammoth, etc.]" (Wendorf et al. 1955:65). The human remains in the Gray Sand, Wendorf and colleagues argued, must therefore be of Folsom age plus whatever time was necessary to deposit the Red Sands (Wendorf et al. 1955:98). In the late 1950s, Folsom was dated to about 10,000 B.P., based on a single radiocarbon age from the Lubbock Lake site (Sellards 1952; Wendorf et al. 1955:98).

The Red Sand was interpreted as representing a "very long period of prevailing aridity" (Wendorf et al. 1955:68), which Ernst Antevs suggested might be the local equivalent of the Altithermal period (quoted in Wendorf et al. 1955:53). But his suggestion was rejected by Wendorf and colleagues who assigned the overlying brown and tan sands (Units 4 and 5) of the Monahans formation to the Altithermal (Wendorf et al. 1955:98–99). Besides, if the Red Sand were Altithermal in age, that implied an unacceptably late occurrence of Folsom, as well as an unacceptably late (post-Pleistocene) survival of *Equus* and *Capromeryx* (Wendorf et al. 1955:53, 97; Wendorf and Krieger 1959:77). They were certain the horse jaw with four teeth from the Red Sand was in primary context, and hence the Red Sand

must predate the Altithermal and coincide with the terminal Pleistocene (Wendorf and Krieger 1959:73; Wendorf et al. 1955:97). There also was some evidence of comparable late Pleistocene aridity from other localities (notably Clovis, San Jon, Lubbock Lake, and the dune fields of Lamb and Hale counties, Texas; see Wendorf and Krieger 1959:74–75; Wendorf et al. 1955:98).

The Red Sand was obviously "the key point in the chronology," but it was rightly anticipated that its history may be "far more complex than is suggested by presently available evidence" (Wendorf et al. 1955:68).

### Initial Efforts to Date the Midland Site

From 1955 to 1958 several attempts were made to date the site using radiocarbon ( $^{14}\text{C}$ ) and the newly devised "uranium daughter-product" method now known as U-Th or U-series disequilibrium (Rosholt 1958; Wendorf and Krieger 1959). Fossil bones from the White Sand yielded a radiocarbon age of ca. 8670 B.P. and fragments from the Gray Sand were assayed at ca. 7100 B.P. (Wendorf et al. 1955:99) (Table 2). Snail shells from the White Sand were dated at ca. 13,400 B.P. and carbon residue from burned caliche in the Gray Sand dated to ca. 20,400 B.P. (Wendorf and Krieger 1959:71) (Table 2). The U-series ages were determined on three samples of bone: two small, unidentifiable bone fragments from the Gray Sand and one from the human skull (Wendorf and Krieger 1959:72). The resulting ages averaged around 20,000 B.P. (Table 2).

In order to resolve the discrepancies among the four radiocarbon ages from the Midland site, Wendorf and Krieger (1959:Figure 3) assembled half a dozen newly obtained radiocarbon ages from other sites on the Southern High Plains (Lubbock Lake, Plainview, and Clovis), then divided all 10 ages into three groups (A, B, C), which, along with "cultural, faunal, and stratigraphic evidence," provided possible ages for the Midland material (Wendorf and Krieger 1959:75).

The ages in Group A, including one from Midland (the shell from the White Sand) in combination with newly determined ages from the other sites in the region, put the age of the Midland skull between ca. 13,400 B.P. (the age on the shell in the White Sand) and 10,000 B.P. (the

Table 2. Radiocarbon and U-series Ages from the Midland Site.

Lab No.	Age B.P.	Dating Method	Material Dated and Remarks
<i>Gray Sand, Locality 1</i>			
M-411	7,100 ± 1000	<sup>14</sup> C	Concentrated carbon...from animal bone from the grey sand <sup>1</sup> Fossil bone fragments <sup>2</sup> from the Gray Sand
L-347	20,400 ± 900	<sup>14</sup> C	Carbon extracted from [burned] caliche...found in Gray Sand <sup>3</sup> Several pounds of...burned caliche...processed <sup>4</sup>
L-347?	23,500	<sup>14</sup> C	Apparent age determined on calcium carbonate from the caliche itself [L-347] <sup>3</sup> Also reported as 23,800 on caliche residue <sup>4</sup>
249088	17,000	U-series	Fragmentary bone <sup>6</sup>
229122	18,000	U-series	Fossil bone <sup>6</sup> Rib <sup>7</sup>
253502	20,000	U-series	Small section from the human skull <sup>6</sup>
	10,600 ± 1000	U-series	Recalculation of 253502 <sup>7</sup>
	12,030 ± 1000	U-series	Recalculation of 229122 <sup>7</sup>
SMU-133B1	12,300 ± 500	U-series	Cranial bone <sup>7</sup>
<i>White Sand, Locality 1</i>			
M-388	8,670 ± 600	<sup>14</sup> C	Turtle bones and other bones <sup>1</sup> Also reported as M-389, M-390, and M-391 from mammoth tusk and two fossil bones from the top of the White Sand <sup>2</sup>
L-304C	13,400 ± 1200	<sup>14</sup> C	Pond snail shells from the white sand <sup>5</sup>

<sup>1</sup>Crane 1956:670.<sup>2</sup>Wendorf et al. 1955:9, 99-100.<sup>3</sup>Olson and Broecker 1959:22.<sup>4</sup>Wendorf and Krieger 1959:71.<sup>5</sup>Broecker and Kulp 1957:1329; Wendorf and Krieger 1959:71.<sup>6</sup>Wendorf and Krieger 1959:72; see also Rosholt 1958.<sup>7</sup>McKinney 1992.

upper bracketing age on Folsom at Lubbock Lake). The Group A ages were considered "perhaps somewhat more plausible" (Wendorf and Krieger 1959:78) than the ages in the other groups because they formed a logical stratigraphic sequence and fit what was known of the age of the associated extinct species and Folsom artifacts (Wendorf and Krieger 1959:75).

The two <sup>14</sup>C ages on bone in Group B (8670 B.P. from the White Sand and 7100 B.P. from the Gray Sand), though in proper stratigraphic order, were considered "least plausible" because (1) they contained very low amounts of carbon and were associated with extinct fauna and (2) acceptance of the ages would date Folsom to post-Altithermal times (Wendorf and Krieger 1959:77-78). The 20,400 B.P. age on the burned caliche in Group C seemed too high, but Wendorf and Krieger (1959:78) (mostly Krieger, according to Fred Wendorf, personal communication 1995) felt it

"should not be entirely discounted." Moreover, the U-series results "all fall rather close" to that radiocarbon age (Wendorf and Krieger 1959:72).

While it was not possible to conclude which of the three chronological scenarios was correct, it seemed clear, as of 1959, that the Midland skull predated Folsom and possibly was as much as 20,000 years old. This age range became fixed in the archaeological literature, and the site generally was accorded an age "more than 10,000, and possibly as much as 20,000, years old" (Jennings 1989:66; also Willey 1966:44).

Continued geochronologic and geoarchaeologic research on the Southern High Plains in the late 1950s and early 1960s (Wendorf 1961; Wendorf and Hester 1975) supported the 1955 and 1959 stratigraphic interpretations of the Midland site, although with some modifications in light of the fact that "the stratigraphic reality [of the site] is probably more complex" than originally

believed (Wendorf 1975:267). By 1975 the red Judkins sands were known to have a more complicated and longer geologic history, representing "a long series of migrations and stabilizations extending back perhaps to early Late Pleistocene" (Wendorf 1975:267; also Green 1961:24–25). Thus, the Folsom occupation on the Red Sands in the dune localities "may not necessarily have been later than the Midland occupation" beneath the Red Sand in the draw associated with the human remains (by 1975 it was accepted by Wendorf that the points in the Gray Sand were Midland points). "Indeed...there is no stratigraphic basis for correlation of the two [archaeological] occupations" (Wendorf 1975:267). Given that the Midland occupation was associated with an older fauna (burned *Capromeryx* and horse), and the co-occurrence of Midland and Folsom at the Clovis site, Wendorf (1975:267) suggested there was "a close chronological correlation of Midland and Folsom, with Folsom surviving somewhat later."

The Midland discoveries, particularly the human remains and Midland points, clearly were significant, but many questions lingered regarding the age of the human remains, and the age of Midland points and their relationship, if any, to Folsom points. Among studies of Paleoindian skeletal remains, for example, Smith (1976:125) included the Midland finds in his survey because of the "essential soundness of [the] geological and archaeological work," but Steele and Powell (1992:306) eliminated Midland from their study because of ambiguities in dating. Debates on Midland vs. Folsom points focused on the cultural and technological relationship of the styles. The argument essentially is whether Midland is "fully contemporary with Folsom and . . . part of the same technological system" (Hofman et al. 1990:240) or if "Midland points represent a distinct and separate complex . . . [and] a different cultural group perhaps closely related to Folsom in time, technology, and economic orientation" (Hofman et al. 1990:243; see also Blaine 1968, 1971, 1991; Irwin 1971; Judge 1970). These unresolved issues sparked our own investigations of the Midland site.

### 1989–1992 Investigations

In 1989, as part of a long term study of the Quaternary history of the draws by Holliday,

archaeological research by Meltzer, and a mutual interest in Paleoindian geoarchaeology, we began our investigations of the Midland site. Given our work in the region, we were puzzled by the fact that the published stratigraphic and paleoenvironmental sequence described at the Midland site did not seem to fit the regional late Quaternary stratigraphic record then emerging (Holliday 1985, 1989b). We were further interested in testing the hypothesis that the Red Sand and Gray Sand in Locality 1 might be, as Antevs himself had suggested, early to middle Holocene "Altithermal" eolian deposits—obviously implying the human remains are not Paleoindian.

### Methods

From 1989 to 1992, 33 cores, augers, and exposures were studied at the site, mostly in Locality 1. The cores and exposures were described in the field (Table 3). Samples from 14 cores, four trenches, and the Locality 3w section were also analyzed for sedimentological and pedological characterization (Table 4).

All cores and exposures studied at the Midland site were numbered consecutively and given the prefix "Mn" (for Monahans Draw). Investigations in 1989 and 1990 involved machine coring using a trailer-mounted Giddings rig (cores Mn-3 to Mn-20) (Figure 4), excavating a test pit in Locality 1 (Tr 89-1), and describing the stratigraphy in Locality 3w (Mn-19), which had the best exposures of the upland dune sequence. This effort was initially complicated by the absence of any surviving datum points, which made it difficult to reconcile our work and observations with the 1950s work. In 1991 and 1992, therefore, 12 hand-dug trenches (Tr 91-1 to 91-11, and Tr 92-1) were excavated in Locality 1 roughly perpendicular to the trenches of Wendorf and Sellards, in hopes of intersecting those earlier trenches. This procedure successfully relocated the ends of the backfilled trenches from Sellards's 1954 work, which in turn (using the maps published in Wendorf and Krieger 1959), allowed us to correlate our units with those earlier excavated. We placed a concrete datum—our Station A—just off the eastern edge of Locality 1, to facilitate any future research at the site (Figure 5).

Beyond the work in Locality 1, six auger holes

Table 3. Stratigraphic Descriptions.

Unit	Stratum	Description
<i>Locality 1, Trench 89-1 (Mn-5 of Holliday 1995a:Table A1.22; see Figure 5)</i>		
3	4s	Sand (7.5YR 5/6 4/6m, 6/6 5/4m 5/6m) 95 cm thick; A-Bw soil formed through out unit; very weakly calcareous; clear lower boundary.
2 and 3	mixed	Sand, mottled (10YR 7/3 6/3m, 7.5YR 6/4 5/4m), 26 cm thick; weakly calcareous; clear lower boundary.
2a	3s;	Sand, heavily mottled (7.5YR 7/4 6/4m 6/6m, 10YR 5/6 4/3m, 6/8 6/6m), 15cm thick; mottled fragments of lake carbonate common, otherwise weakly calcareous; bones of bison, horse, and antelope, and archaeological debris locally common; clear lower boundary.
1	1	Sand (7.5YR 8/2 7/4) with pockets of gravel and fragments of lake carbonate; at least 100 cm thick; bones of mammoth, camel, horse, wolf, and antelope locally common.
<i>Locality 1, Trench 91-3, east end (see Figure 5)</i>		
2b	3s	Sand (10YR 6/4, 6/3m) 80 cm thick; few fragments of lake carbonate scattered through lower half, otherwise, weakly calcareous; abrupt lower boundary.
	3c*	Marl (10YR 8/2 7/3m); discontinuous, up to 10 cm thick; strongly calcareous; abrupt lower boundary.
1	1	Sand and gravel; thickness undetermined.
<i>Locality 3w (Mn-19 of Holliday 1995a:Table A1.22; see Figure 2)</i>		
Tan Sand		Sand (7.5YR 7/4 5/3m); 15 cm thick; noncalcareous; abrupt lower boundary.
Upper Red Sand		Sand, 165 cm thick; A horizon (7.5YR 4/6 3/6m), 40 cm thick, clear lower boundary; Bw horizon (5YR 5/8 4/6m, grading down to 5YR 6/8 4/8m), 115 cm thick, weak subangular blocky structure, clear lower boundary; Bt horizon (5YR 6/8 4/8m), 10 cm thick with few 1–3mm clay bands (5YR 5/8); noncalcareous; clear lower boundary; Folsom artifacts locally common at base of unit.
Lower Red Sand		Sand (5YR 5/8 4/6m, 6/8 4/8m) at least 170 cm thick; A horizon (5YR 6/6 4/6m), 70 cm thick, clear lower boundary; Bt horizon (5YR 5/8 4/6m), 50 cm thick, weak prismatic to moderate subangular blocky structure, few thin clay films, clear lower boundary; Bw horizon (5YR 6/8 4/8m), ≥ 50 cm thick, weak subangular blocky structure; noncalcareous.

*Note:* Unit terms follow Wendorf et al. (1955) with some modifications from this paper; strata are correlations with Holliday (1995a) (see also Table 1). Colors are Munsell, dry and moist (m).

\*Probably identified as White Sand by Wendorf et al. (1955) and Wendorf and Krieger (1959).

(Mn-21 to Mn-26) and a ground-penetrating radar transect were put in between Localities 1 and 3 for additional stratigraphic correlation. Four more cores were taken along the axis of Monahans Draw above and below the dune field to correlate the deposits in Locality 1 with the stratigraphy elsewhere along this draw and with other draws. Finally, all blowouts on the site were surveyed for archaeological materials, and several local collections were examined.

We were unable to recover charcoal or bone for radiocarbon dating. Had we found such materials in Locality 1, the potential for contamination by sewage effluent probably would render the resulting dates suspect.

## Results

The keys to our interpretations are: (1) that the strata in Locality 1 are part of the fill in Monahans Draw; (2) that the soil stratigraphy in Locality 3 is more complex than initially believed; and (3) that the site stratigraphy can be understood in terms of a general stratigraphic sequence developed for other draws in the region (Holliday 1995a). In the context of regional draw stratigraphy, the valley fill in Locality 1 is separated into a valley-axis facies, which occurs just south of the blow out, and a valley-margin facies in the blow out.

The valley-axis stratigraphy essentially is identical to that observed in other reaches of

Table 4a. Laboratory Data for Locality 1.

Unit	Depth	% of <2 mm Fraction <sup>1</sup>								USDA	%	% Org.
	in cm	VCOS	COS	MS	FS	VFS	Sand	Silt	Clay	Texture	CaCO <sup>3</sup>	Carbon
Trench 89-1												
3	0-5	0	1	33	44	17	95	2	3	S	1	.7
	7-15	0	0	42	47	2	91	2	7	S	1	.2
	15-25	0	0	51	23	17	92	2	6	S	1	.0
	50-60	0	0	66	26	2	93	2	5	S	1	.0
	85-95	0	0	27	44	23	95	1	4	S	0	.1
Mix	96-105	0	0	67	25	1	92	2	6	S	1	.0
	110-122	0	0	19	38	35	92	3	5	S	1	.0
2a	125-130	0	0	63	28	1	92	2	5	S	1	.0
	132-138	1	2	19	30	31	84	7	9	LS	13	.3
	135-140	0	0	10	77	1	88	6	6	LS	1	.1
1	145-150	0	0	2	24	54	81	13	6	LS	6	.2
Trench 91-3												
2b	0-45	0	0	28	40	22	91	7	2	S	2.7	.3
	45-80	0	1	26	41	25	93	5	2	S	4.2	.0
3c <sup>2</sup>	55-100	0	1	26	39	22	89	8	3	S	17.4	.1

Table 4b. Laboratory Data for Locality 3w.

Unit	Horizon (Depth in cm)	% of <2 mm Fraction <sup>1</sup>								USDA Texture	% CaCO <sup>3</sup>	% Org. Carbon
		VCOS	COS	MS	FS	VFS	Sand	Silt	Clay			
Tan Sand	C	0	1	27	47	21	96	3	1	S	.1	.2
	0-15											
Upper Red Sand	Ab1	0	1	39	44	12	95	3	2	S	.0	.3
	15-55											
	Bw1b1	0	0	39	41	15	96	2	2	S	.2	.0
	55-100											
	Bw2b1	0	0	32	56	10	97	1	2	S	.0	.0
	100-170											
Lower Red Sand	Btb1	0	1	62	25	9	98	1	1	S	.0	.0
	170-180											
	Ab2	0	1	38	42	11	93	5	2	S	.0	.0
	180-250											
	Btb2	0	1	37	46	10	94	1	5	S	.0	.0
	250-300											
	Bwb2	0	1	40	46	10	96	2	2	S	.0	.3
	300-350											

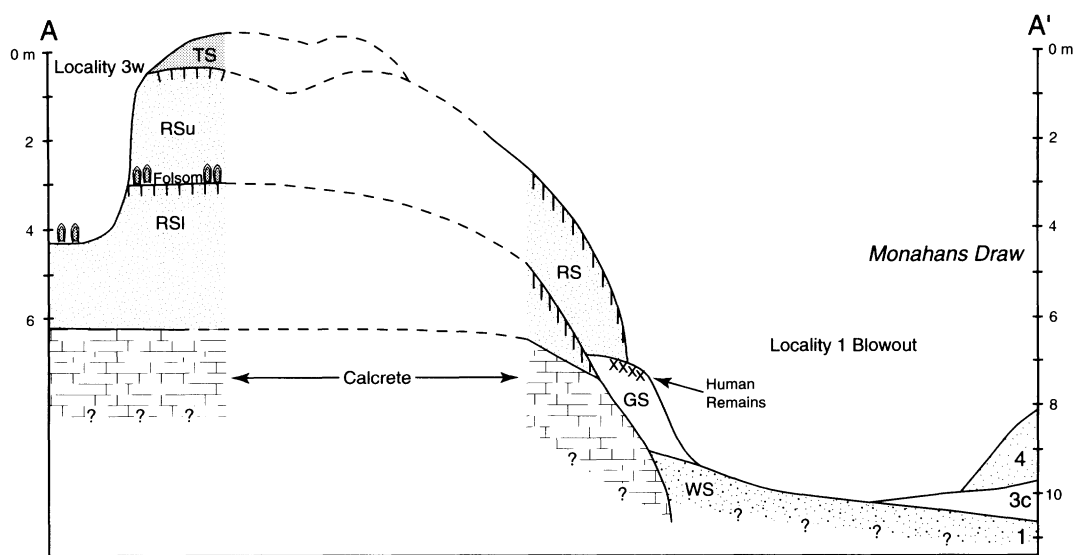
Note: Laboratory methods follow Singer and Janitzky (1986).

<sup>1</sup>< 2 mm fraction: VCOS = very coarse sand, COS = coarse sand, MS = medium sand, FS = fine sand, VFS = very fine sand; USDA Texture: S = sand, LS = loamy sand.

<sup>2</sup>Stratum 3c of Holliday (1995a); probably identified as White Sand in Wendorf et al. (1955) or Wendorf and Krieger (1959).

Monahans Draw and in other draws (Holliday 1995a), and also is easily correlated with the valley margin facies exposed around Locality 1 (Figure 6). Terminology for the valley-axis stratigraphy follows Holliday (1995a). Alluvial coarse sand and gravel (Stratum 1), a facies of the White Sand, is at the bottom of the section. Above

Stratum 1 is a highly calcareous sand (sandy marl; Stratum 3c), equivalent to the Gray Sand. This deposit is composed of calcium carbonate accumulated in a lake or pond, but it also contains significant additions of eolian sand. The sandy marl was observed in a few of our trenches in Locality 1 (e.g., Tr 91-3, Table 3) and probably was identi-



**Figure 6.** Cross section of the Midland site from Locality 1 to Locality 3w (A–A' on Figure 2) showing the stratigraphic relationships of the sediments and archaeology (WS = White Sand, GS = Gray Sand, RS = Red Sand; RSI = lower Red Sand, RSu = upper Red Sand, TS = Tan Sand). Note the wedge of sand (probably the lower Red Sand) between the Red Sand (as originally identified by Wendorf et al. 1955) and the calcrete.

fied as White Sand in the 1950s. The sandy marl is overlain by a massive loam (Stratum 4) with a moderately well-developed soil (A-Bt profile). These units in other draws in the region are roughly early and middle Holocene in age, which has significant implications for the age of the skeletal material, as discussed below.

The valley-margin facies of the fill in Monahans Draw exposed in the Locality 1 blowout is underlain by a massive calcrete. This calcrete forms the north wall of the draw, buried under dunes that rim the north and northwest side of Locality 1 (Figure 6). The deepest sediments encountered—the White Sand—are calcareous silty and clayey loams, interbedded with thin lenses of low-carbonate sands and gravels. The sand and gravel are alluvial, but some of the more calcareous zones appear to be composed of fragments of carbonate derived from the bedrock calcrete.

The Gray Sand, including Units 2a and 2b, in the valley-margin setting all are equivalent to Stratum 3s of Holliday (1995a). Stratum 3s, observed throughout the draws of the region, is a facies of the marl. It is composed of eolian sand (derived from the surrounding uplands) with some slopewash additions of sand and coarser clastics, all of which accumulated along the mar-

gins of the draw as the marl accumulated along the axis. Wendorf (personal communication 1995) believes that the Gray Sand was deflated from and is a mixture of the White Sand and Red Sand. We believe that the Gray Sand was derived from the surrounding uplands, possibly from older dunes, but more likely from the Blackwater Draw Formation. But we all agree that the Gray Sand is an eolian deposit that was subsequently water saturated. Units 2a and 2b are discontinuous in Locality 1, and locally both are missing due to erosion. The older subunit, 2a, is a weakly calcareous sand, mottled with reddish brown and yellowish brown colors (Table 3, mottled zone) reflecting a fluctuating water table. Within 2a there are scattered fragments of calcrete, noted by Wendorf et al. (1955:23, 29) and probably eroded off of the valley wall. The presence of the calcrete fragments also suggests that some of the sand in 2a is slopewash. Unit 2b is a weakly calcareous, reddish brown sand more uniform in color than 2a due to the absence of mottling (Table 3).

The Red Sand (Stratum 4s of Holliday 1995a) is a massive, eolian, fine sand exhibiting weak soil development (A-Bw profile). Recent sands (Units 4 and 5 of Wendorf et al. 1955; Stratum 5s of Holliday 1995a) devoid of any evidence of in

situ weathering bury the Red Sands and form the active dunes throughout the site.

In Locality 3w within the dunes, the sands are composed of three distinct eolian layers: the lower Red Sand, upper Red Sand, and the Tan Sand. The sands are underlain by the same calcrete forming the bedrock valley wall (Figure 6). The two sub-units of the Red Sands were not discussed originally by Wendorf et al. (1955), although a buried "humic zone" (buried A horizon) was noted within the Red Sand near Locality 3 (1955:33). The lower Red Sand is the typical Red Sand of Wendorf et al. (1955). The zone is reddish yellow to yellowish red (Table 3), relatively compact, and contains sufficient clay (Table 4b) to make it somewhat resistant to wind erosion (producing the small residual mounds or hummocks noted by Wendorf et al. 1955:32). The compactness and at least some of the clay in this zone is the result of soil formation, indicated by an A horizon preserved at the top and a moderately developed Bt horizon (Table 3). The upper Red Sand is similar in color to the lower Red Sand, but exhibits substantially less pedogenic alteration with only an A-Bw profile (Table 3) similar to the Red Sand in Locality 1. The Tan Sand here is the same recent sand that forms dunes in Locality 1 and throughout the dunes.

Our correlation of the stratigraphy between Localities 1 and 3, and the observation that there are at least two red sands, yields three particularly significant results. First, the Gray Sand in Locality 1 is inset against the lower Red Sand (and calcrete), i.e., the lower Red Sand is stratigraphically below the Gray Sand (Figure 6) (a possibility first raised by Wendorf et al. [1955:6], and suggested by Glen Evans in a stratigraphic profile he prepared for E. H. Sellards (drawing on file in Sellards Collection, Texas Memorial Museum, Austin). Second, the Red Sand in Locality 1 is the same layer as the upper Red Sand in Locality 3 (Figure 6). Third, the Folsom occupation in Locality 3 is associated with the buried surface atop the lower Red Sand (Figure 6). These stratigraphic considerations clearly show that the relationship of the Folsom finds to the Red Sand in the dune blowouts cannot be used to provide an age estimate for the Gray Sand and associated human remains in the draw. In his later publication, Wendorf (1975:267) alluded to this possibility.

### Additional U-Series Dating

Coincident with our field investigations, McKinney (1992) began a new round of U-series analyses on bone from Midland. He produced an age of  $12,300 \pm 500$  B.P., based on a recalculated  $^{234}\text{U}/^{238}\text{U}$  ratio from a sample of the human skull. Rosholt (1958) originally assumed unity for this ratio. Using the newly determined ratio, McKinney recalculated the two U-series ages determined by Rosholt (Table 2). Based on arithmetic averaging of the three ages, he proposed a date of  $11,600 \pm 800$  B.P. for the bone and concluded that the skeletal remains are from a Clovis occupation.

### Discussion and Conclusions

The various investigations of the Midland site and the Midland skeleton produced a number of contradictory results regarding the evolution and geochronology of the site as well as the age of the human skeletal remains and the artifacts. Several points are at issue: What is the age of human bone? What is the age of the Gray Sand? What was the relationship of the human bone to the Gray Sand? What was the stratigraphic relationship between the Folsom points in the dunes, and the Midland points and skeletal material in the draw? And what is the technological relationship between Midland points and Folsom points? Our work was largely geoarchaeological and, therefore, did not address the latter question (but see Amick 1995 and Hofman 1992 for some reasonable hypotheses), but we can offer data and interpretations to help deal with the other questions.

Our stratigraphic investigations and correlations show that the Red Sand in Locality 1 is the same layer as the upper Red Sand in Locality 3 and that the Gray Sand is an eolian valley-margin facies of a sandy lacustrine carbonate (Stratum 3c of Holliday 1995a), which is ubiquitous throughout the draws of the Southern High Plains. The Red Sand in Locality 1, therefore, is a post-Folsom deposit, but this information provides no other clues to the age of the Gray Sand. The Gray Sand/Stratum 3c is not dated in Monahans Draw, but more than 30 radiocarbon assays bearing on its age are available from other localities in the region (Holliday 1995a). The deposit is time-transgressive, but rarely dates to  $> 10,000$  B.P.

and is < 10,000 B.P. at all dated localities in the Colorado River drainage.

There is little doubt that the bones were being eroded from the Gray Sand when found in 1953. Initial association of the bone and Gray Sand is less clear, however. The bone was heavily weathered and highly fragmented when found and there was no evidence of a burial pit (Wendorf et al. 1955:41). These considerations and the proximity of the find to the valley wall (< 30 m to the north) raise the possibility that the bone was eroded off of the valley margin and into the Gray Sand. The presence of calcrete fragments throughout the Gray Sand directly demonstrates that material derived from the valley wall is incorporated into the nearby valley-margin facies. Redeposition, which could certainly include artifacts and bone at this site, is a common process along the valley margins of the draws of the Southern High Plains (Holliday 1995a). Wendorf and Krieger (1959:70) observed concentrations of hearth stones along with burned *Capromeryx* remains in the Gray Sand, which might refute the hypothesis that the cultural material within the Gray Sand was redeposited. However, they also note that "neither of these burned-rock piles was arranged in a regular shape; apparently they had been cast aside from some nearby hearth or roasting pit, which unfortunately could not be located" (Wendorf and Krieger 1959:70). Clearly, Wendorf and Krieger recognized the possibility of redeposition, so the questions then become whether it did occur, and what were the mechanism and the source.

We do not have answers to all these questions, but we can speak to possible mechanisms of redeposition. In general, we believe that the most likely mechanism was movement of materials off the valley wall. In our experience on the site we saw no evidence that any sediments in Locality 1 were otherwise affected by agents such as alluvial cutting and filling, saturation and fluidization, or bioturbation. Likewise, Wendorf (personal communication 1995), who had the best look at the original artifact- and bone-bearing strata at the site, believes that bioturbation was inconsequential.

Several lines of evidence were offered by other investigators to support the idea that the Gray Sand and the human remains are of Folsom age ( $\geq 10,000$  B.P.) or older, but the data are ambigu-

ous. Similarities in fluorine content and degree of fossilization among the bone from the White and Gray sands, including the human remains, were used to argue that all of the bone was "essentially contemporaneous" and "the human fossil was unquestionably contemporaneous with the Pleistocene fauna from this site." (Wendorf and Krieger 1959:67). Fluorine content and fossilization are postdepositional characteristics of the bone, however, and are dependent on local environmental conditions such as groundwater chemistry and history. Similarities in these characteristics do not necessarily indicate contemporaneity (e.g., Cotter 1991).

The fragments of teeth and bone from extinct horse and extinct antelope found in the Gray and Red sands likewise could be secondary; many of the faunal pieces could be redeposited from Stratum 1 (as suggested by Wendorf and Krieger 1959:73), and the distal end of a *Capromeryx* radius or other bones from the Gray Sand could have come off of the valley walls. Assuming this particular piece was in situ, however, provides only a general clue to the minimum age of the Gray Sand. *Capromeryx* was found at Lubbock Lake (Figure 1) in deposits of Folsom age ( $\geq 10,000$  B.P.) or possibly younger (< 10,000 B.P.) (Johnson 1987:Table 7.1; Eileen Johnson, personal communication 1992).

The new U-series age estimates also suggest a late Pleistocene age for the human bone. There are, however, problems with the method that must be addressed before the ages can be accepted. McKinney's date of  $11,600 \pm 800$  B.P. for the human bone is problematic because it is based on a simple arithmetic average of three ages determined on three different pieces of bone, each of which could have had very different weathering histories. McKinney also applied a  $^{234}\text{U}/^{238}\text{U}$  ratio determined on one sample to the other two. The  $^{234}\text{U}/^{238}\text{U}$  ratio can vary among samples, however, because each fragment may have a unique weathering history. Bone also is notoriously difficult to date using the U-series method because it often is not a closed system and can take up and lose uranium (Schwarcz and Blackwell 1992; Szabo 1980). Schwarcz and Blackwell (1992:Table 15.2) tabulated data from a number of efforts to date bone by means of U-series and showed that such ages can

be younger or older than numerical ages determined by more reliable methods. Furthermore, as pointed out by Fred Wendorf (personal communication 1995), a U-series age is not directly comparable to a radiocarbon age, but if accurate it should approximate dendrocalibrated radiocarbon results. A calibrated radiocarbon age of 11,600 years roughly corresponds to an uncalibrated radiocarbon age of 10,000 B.P. (Stuiver and Reimer 1993). The U-series results do not support a Clovis affiliation for the human remains, but rather, if accurate, a late- or post-Folsom age.

We can offer no definitive conclusion on the age of the human remains from the Midland site. Based on our fieldwork and an examination of data from all other investigations, however, we find no compelling evidence that the human remains from the Midland site are older than Folsom age. Stratigraphic correlations with radiocarbon-dated sections elsewhere further suggest that the bone may be the same age as or younger than Folsom ( $\geq 11,000$  B.P.). Whether it is, in fact, Altithermal in age, is a question that can be resolved only if, and when, it is possible to directly date the human skeletal remains. For now, that opportunity eludes us.

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and colleagues did there was and remains an important first step in our understanding of the prehistory and paleoenvironments of this region.

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