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Spatial Distribution of Pleistocene and Holocene Faunal Remains, South Block Excavations

Christopher L. Hill
Boise State University

David C. Batten

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Introduction

The fossil remains of mammoth and other Pleistocene fauna found along and near the escarpment of the west shore of Lima Reservoir in Centennial Valley have been the subject of field investigations since the 1980s. Summaries of earlier studies conducted at the locality are presented in various published and unpublished sources, including Albanese, Davis, and Hill (1995), Bump (1990), Davis and Batten (1996), Dundas (1989, 1990, 1996), Hill and Albanese (1996), and Hill, Davis, and Albanese (1995).

The spatial distribution of Pleistocene-age and Holocene-age fossils recovered during the Museum of the Rockies' (MOR) 1994-1996 excavations provides information pertinent to the stratigraphic and taphonomic interpretation of the Merrell Locality. The South Block designates excavations conducted within the site grid 120-140N. It includes Test Pit/Excavation Area E (excavated in 1994) and Excavation Areas J-X (excavated in 1995-1996) (Figures 4, 11, and 22). In this paper, each 2 x 2-m excavation square or portion of a 2 x 2-m test pit or excavation square aligned with the site grid in the South Block is referred to by the term "Excavation" or "Excavation Area" and a letter designation. These correspond to a grid location in the southwest corner of the 2 x 2. For example, Excavation Area K is the 2 x 2-m square with its southwest corner located at 123N/125E. Each 2 x 2-m square was divided into four 1 x 1-m quadrants, which were referred to by the letter and a lower case directional quadrant label, i.e., quadrant Knw is the northwestern quadrant of Excavation Area K, and its southwest corner is located at 124N/125E (see Table 2). Unless otherwise indicated, directions refer to an orientation based on grid north (Figure 4). Only the west halves of Excavation Areas J-P were studied since the east halves of these Excavated Areas had been destroyed by erosion. The escarpment adjacent to the reservoir exists between grid line 125E and grid line 126E and marks the location of active erosion.

Data pertaining to the spatial location of fossils in this area were derived from standardized field records compiled

during each of the three field seasons under supervision by Batten (see Batten 1994, 1995, 1996). The locations of fossils recovered from 1994 and 1995 were initially compiled and placed on a master grid by Hill. This compilation was then reviewed and corrected by Batten. Throughout this report, the designation of fossils collected by MOR follows primarily the identifications available in Dundas (this report), although subsequent studies of the mammal collection have been undertaken by Hill. The locations of fossils recovered in 1996 were superimposed on this grid using the standardized field records and information documented in Batten and Davis (1996). There is the possibility of a fairly secure assessment of the associations of fossils and lithostratigraphic contexts from the 1996 excavations because of the practice of collecting paired fossil and sediment field specimens (see inventory in Batten and Davis 1996) and the placement of excavation level markers on the stratigraphic exposures.

Additional observations on the stratigraphic context of the South Block were made by Hill during geologic studies between 1994 and 2001; besides interpretations in this paper, those observations are partially summarized in Hill (this report).



Figure 22. Excavations during the 1995 field season of the South Block, Merrell Locality (C. L. Hill photo).

Spatial Distribution of Faunal Remains

Information regarding the spatial distribution of bones recovered from the Merrell Site is available from a variety of sources. Prior to the MOR excavations, spatially controlled excavations were made under the auspices of the Bureau of Land Management (BLM) by Robert Bump, and the University of Montana (UM) under the direction of Tom Foor. A draft report of the fieldwork completed in 1988 and 1989 by Bump is on file at the Dillon, Montana office of the BLM (Bump 1990). Details concerning the UM studies are derived from notations made by Foor on a topographic map of the locality drafted by Troy Helmick for the MOR. Additional information was provided by Robert Dundas in the form of an inventory connecting the notations made by Foor with fossils recovered during these excavations. Based on discussions with Dundas in September of 1997, additional information may be available that would allow the investigations made by the UM to be correlated with the MOR project's stratigraphic descriptions and interpretations.

The 1994-1996 MOR investigations included testing in areas designated Excavation Areas E, J-X, a backhoe trench, and along the escarpment (Figure 11). These sources provide data regarding the vertical and horizontal arrangement as well as the general stratigraphic context of the fossils. Bones were recovered throughout the sequence of sedimentary deposits studied.

Faunal Remains Recovered from the South Block Area Prior to 1994

Based on Map 2 in the 1989 Bump report, long bones of mammoth were recovered during excavations in the vicinity of what is now designated the South Block (Figure 11). The general location of the profile described by Bump was verified during his visit to the locality in 1996. The approximate horizontal location of these bones would be along the escarpment intersection with MOR grid coordinate 121N (Figure 16). Besides *in situ* fossil material, bones were also recovered along the beach in front of the escarpment. These fossils can be assigned a tentative horizontal provenience by correlating Bump's soil study with the stratigraphic sequence described by the MOR (Hill 1995, this report; Albanese, this report). Bump observed Pleistocene vertebrate fossils in level 3 and underlying level 4. Level 3 is thought to be equivalent to the lowermost organic facies of stratum B (=local lithology 2a at Test Pit/Excavation

Area E), and level 4 is interpreted as probably equivalent to the top of stratum A. Bump observed the presence of impressions made by bone within the stratum A equivalent sediments when the long bones of mammoth were removed. Similar bone impressions in the sediments were observed during the MOR excavations. The bones observed in stratum A were interpreted by Bump as having original context in stratum B; he proposed that the bones had been displaced downward into stratum A through cracks or faults.

Remains of mammoth were recovered by the UM along the escarpment in the vicinity of the MOR South Block (F18 and A103, UM Paleontology Collections, Department of Anthropology field record, data from T. Foor and R. Dundas). It might be possible to connect the horizontal and vertical locations of those materials with the MOR studies using records not available at the time this paper was written.

Spatial Distribution of Faunal Remains from Museum of the Rockies Excavations

Both horizontal and vertical information are available for fossils collected during the MOR excavation in the South Block (Figure 23). Details are provided in a series of summaries developed after each field season (Batten 1994, 1996; Batten and Davis 1996) as well as the field records and forms archived at the MOR. In general terms, both vertical and horizontal control over the location of fossils is predicated either on (1) the direct measurement of specimens in relation to a three-dimensional site grid or (2) recovery as part of a collection of materials found within an excavation interval of known thickness within a known coordinate location in the site grid. In many instances, there is also the possibility that the fossil specimens can be placed within the context of the sedimentary matrix. However, especially in regard to materials not recovered *in situ*, assemblages of specimens collected from some excavation intervals may represent fossils derived from several different sedimentary deposits.

Description and Interpretation of Spatial Distribution of Faunal Remains

The approximate horizontal distribution of fossils mapped *in situ* within the South Block is presented in Figures 23-25. The maps are based on data available in the field records of the 1994-1996 MOR excavations. The taxonomic designation of fossils follows essentially the identifications made by Dundas (1996, 1997, this report).

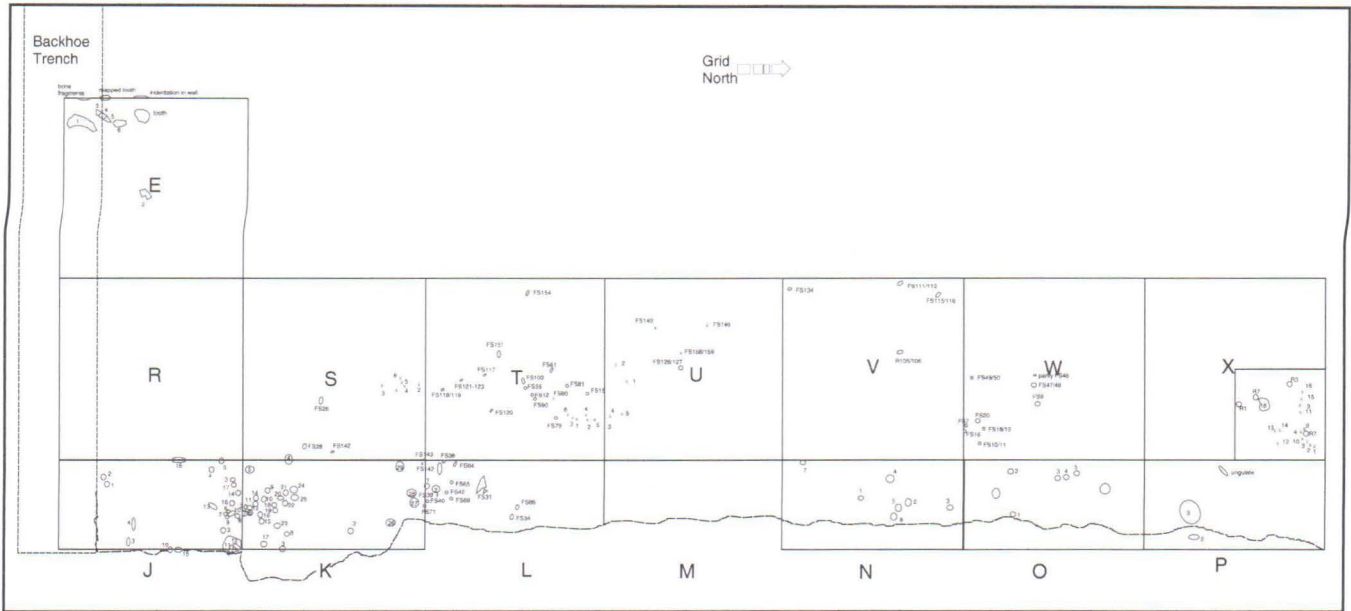


Figure 23. Spatial distribution of fossils at South Block, Merrell Locality (compiled by C. L. Hill).

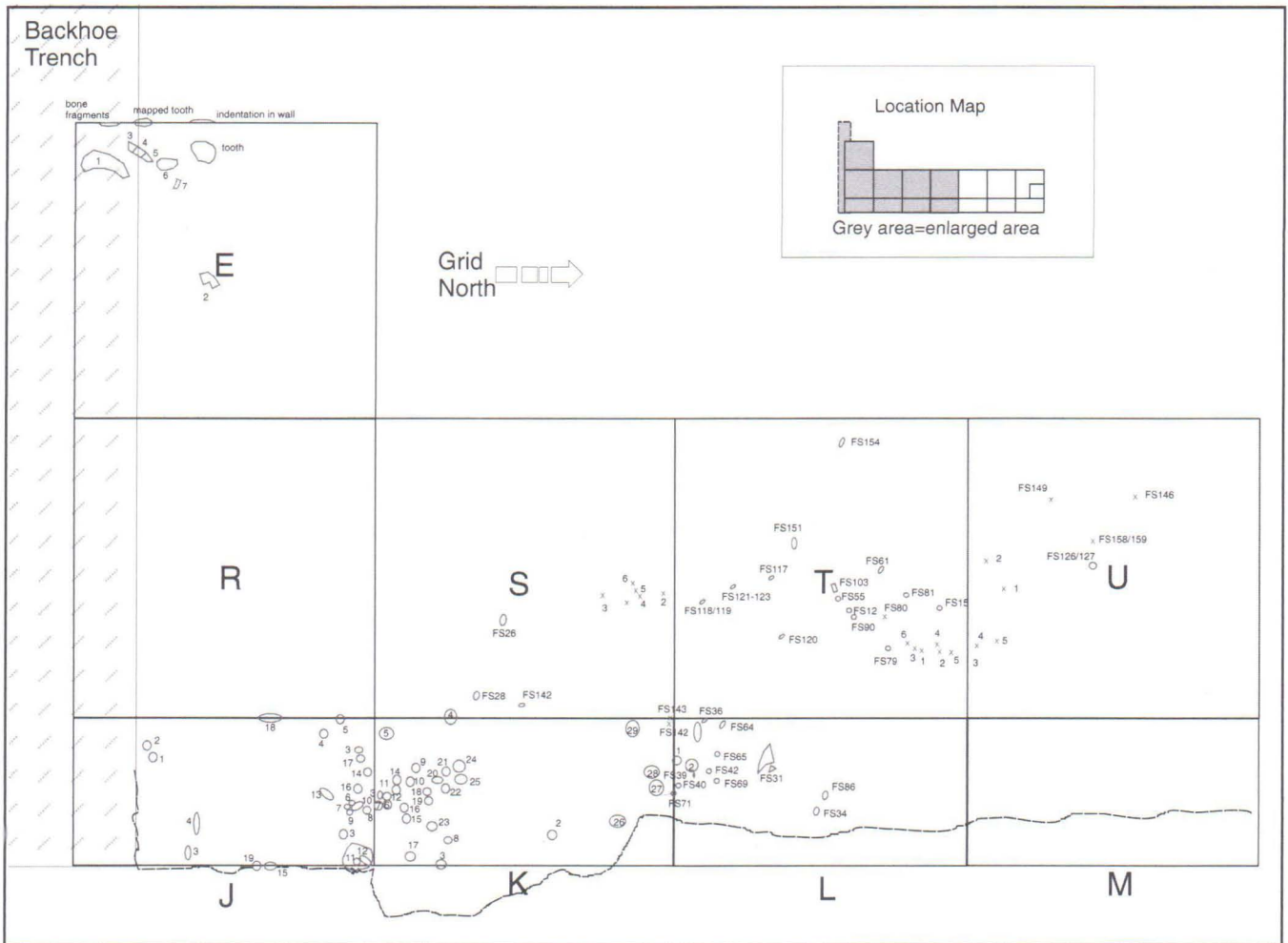


Figure 24. Spatial distribution of fossils in Excavation Areas E, J-M, and R-U, South Block (compiled by C. L. Hill).

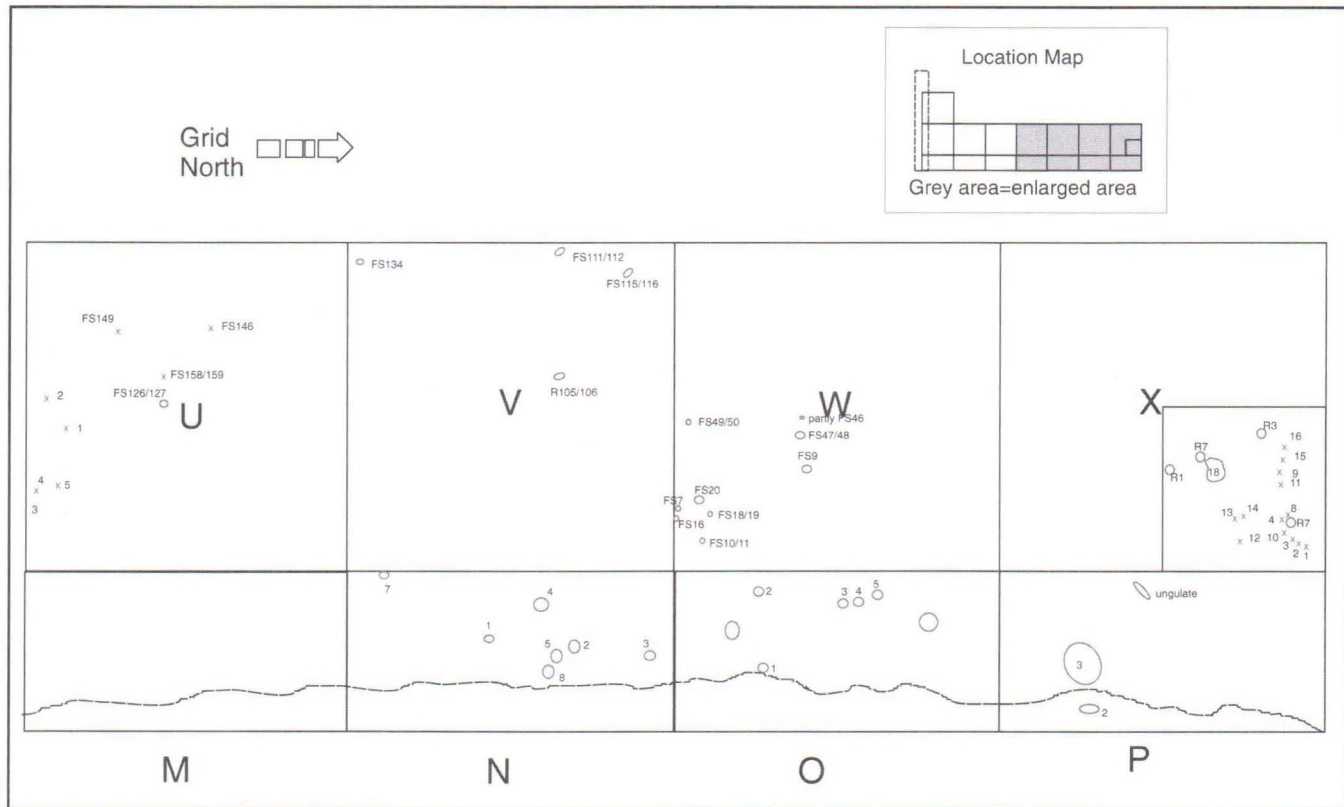


Figure 25. Spatial distribution of fossils in Excavation Areas M-P and U-X, South Block (compiled by C. L. Hill).

Excavation Area E

Excavation Area E (referred to as 1994 Test Pit E in Davis et al. 1995) was situated at approximately 121-123N/121-123E on the site grid (Figures 4 and 11). The landform surface in this vicinity slopes toward the south and east. Thus, the surface elevation of the SW corner of Excavation Area E at about 2,012.15 masl (6,601 fasl) is about 5 cm (2 in) lower than the NW corner, about 9 cm (3.5 in) higher than the NE corner, and 23 cm (9 in) higher than the SE corner at ground surface. Depth elevations for the 1994 MOR excavations were measured with reference to these known surface elevations. (Whenever depths are referred to, they should be understood to be depths below ground surface [b.s.].) In terms of the spatial distribution of fossils, the excavations in Excavation Area E are important because they provide an indication of the kinds of fossils recovered throughout the entire South Block sedimentary sequence (including a screened sample of the entire thickness of stratum C).

Two forms of mixing are potentially indicated within Test Pit/Excavation Area E. From level 20 and above, the presence of Holocene-age ground squirrel remains, as well as sedimentary structures thought to be the result of rodent burrowing, hint at the possibility of fossil movement

due to bioturbation. Faulting and liquefaction features also indicated potential for the redistribution of fossils within the sequence.

In the northern half of the excavation (En), stratum C (primarily silty sediments with lenses of sands and gravels) Hill (1995, this report) characterized the sequence to about 150-160 cm (59-63 in) b.s. At about this depth, pockets of a darker, generally reddish brown dark silt (referred to as "dark red clay" in some of the excavation field records) began to be observed, indicating the presence of the upper facies of stratum B. In the south half of the excavation (Es), gravels or sands of stratum C were still present at 150-170 cm (59-67 in) b.s., with the upper facies of stratum B dominating below about 160 cm b.s. Above this, the faunal remains generally can be attributed to either (1) the uppermost colluvium, (2) stratum C (either of the local lithofacies of coarser clastics or silts), and/or (3) areas of bioturbation (Figure 26).

Within levels 1-20, in both the north half and the south half of the excavation (En and Es), ground squirrel (*Spermophilus* sp., Dundas, this report) bones were found. These appear to be Holocene-age bones and are one indication of the degree of bioturbation that has affected the Excavation E sequence. Remains of muskrat (*Ondatra*

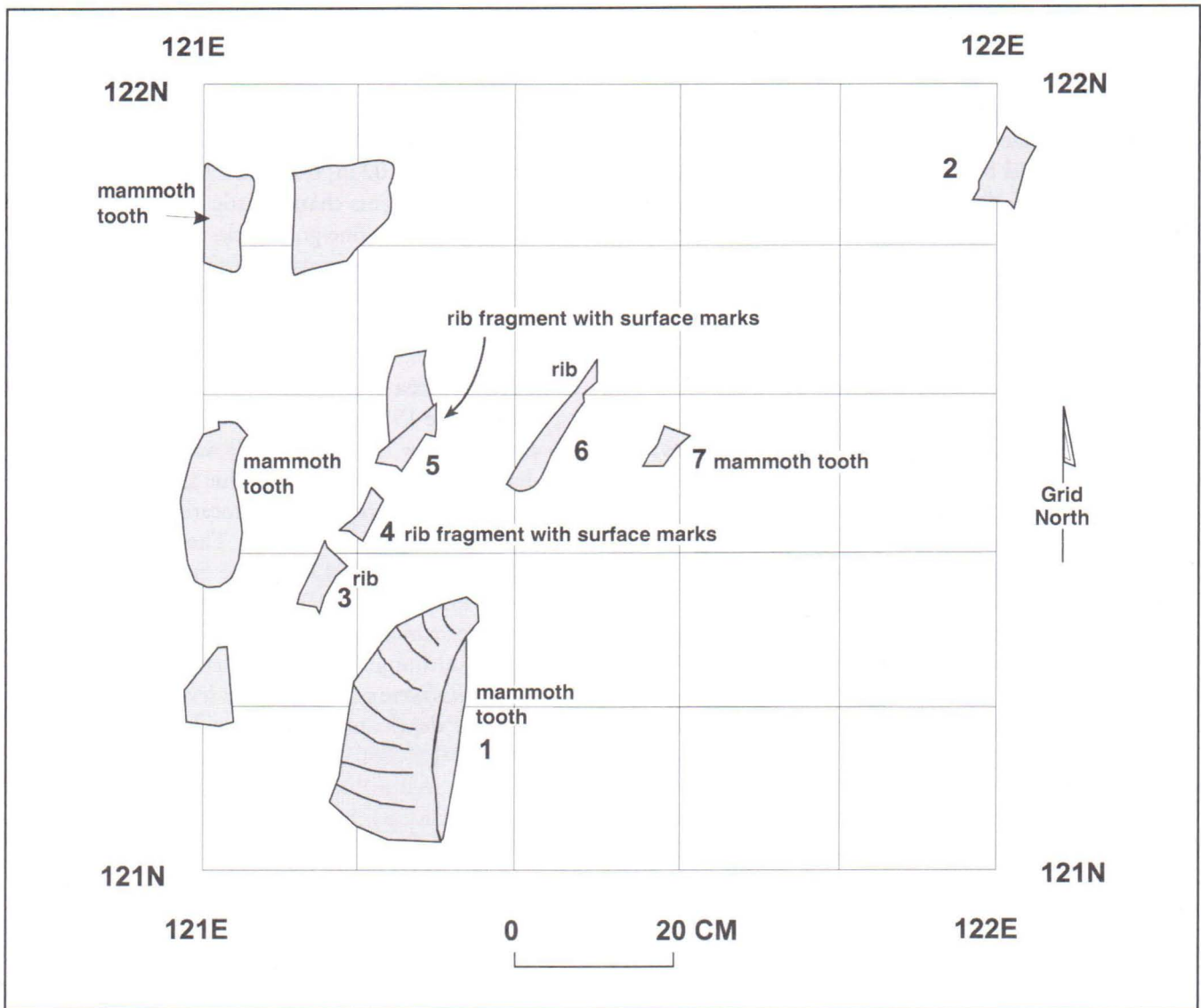


Figure 26. Remains of mammoth mapped in Test Pit/Excavation Area E, South Block (compiled by C. L. Hill).

zibethicus) were recovered in Es level 7 and near the bottom of Es level 25; bones perhaps of a pocket gopher (cf. *Thomomys*) were found in Es level 11.

Remains of mammoth were recovered in two "sets." The upper set consists of four excavation intervals found only in En between levels 8 and 17. Level 8 (70-80 cm [27-31 in] b.s.) contained a limb bone fragment possibly referable to mammoth (*Mammuthus* sp., Dundas, this report). Level 12 contained fragments of a mammoth molar (Dundas, this report). Level 14 (in En) also contained fragments of enamel referable to mammoth (Dundas, this report). Finally, mammoth remains were also recovered from level 17. Except for the lowermost specimen, these mammoth remains are probably either derived from stratum C or had been moved into this part of the sedimentary sequence, perhaps principally by burrowing ground squir-

rels. The level 17 (about 160-170 cm [63-67 in] b.s.) remains could be attributable to stratum B.

The lower set of mammoth remains was found in levels 25-27 in both halves of the 2 x 2. Within Es level 25 (depth 240-250 cm [94-98 in] b.s.), a mammoth tooth fragment (specimen Es-25-1) and a rib (specimen Es-25-3) were found in the dark-colored sediments of stratum B (Figures 24 and 26). Excavation Area En level 26 contained fragments of rib (En-26-3), tusk (specimen En-26-1), teeth, and phalange probably attributable to mammoth (Dundas, this report), while Es level 26 contained mammoth tooth fragments (e.g., Es-26-7). This level contained sediments characteristic of both strata A and B. Thus, the remains of mammoth from level Es-26 are probably derived from stratum A, but could also be from stratum B. Level 27 also contained part of a mammoth tooth as well as tusk frag-

ments. The fossils were mostly in the lowermost portion of stratum B, but perhaps at least partially directly on sands of stratum A in the southwest corner of the excavation. Bones (including fragments of mammoth teeth, cf. Dundas, this report) recovered from Es level 27 (260-270 cm [102-106 in] b.s.) could be derived from either stratum B or stratum A, since dark-colored sediments were present on the east side of the excavation and sands were observed on the west side at that level.

Bone fragments of large ungulates (Dundas, this report) were found in En levels 6, 9, 15, 18, 20, and 21. A fragment of camel bone (*Camelops* sp.) was recovered from the north half of Excavation E at level 15 (specimen EN-15-2) (Dundas, this report). Below about 160 cm (En level 17, ca. 160-170 cm [63-67] b.s.), most faunal remains can likely be attributed to either stratum B or the top of stratum A, although bioturbation in the form of rodent burrows signals the possibility of intrusion and mixing. Below about 160 cm [63 in] b.s., the upper facies of stratum B were encountered and most of the fossils recovered can likely be attributed to these deposits (including a tooth fragment of a large ungulate recovered from level 18, ca. 170-180 cm [67-71 in] b.s.).

The presence of gravels within Excavation Area En levels 19 and 20 (180-210 cm [71-83 in] b.s.) indicates the possibility of fossils from stratum C in those levels. However, isolated gravels were also observed in stratum A. Several tooth fragments and bone were recovered from these levels, including the extreme distal end of a left humerus referable to duck (Anatidae) in level 20 (Dundas, this report).

The darker, more organic-rich facies of stratum B was observed during excavation of the En unit at ca. 220 cm [87 in] b.s. Small patches of gray sediments observed in level 24 (230-240 cm [90-95 in] b.s.) indicate the potential intrusion of stratum A deposits, although the lower facies of stratum B persists in the eastern half of the unit until level 27 (260-270 cm [102-106 in] b.s.). Excavation E level 25 contained a bivalve; bivalves are more commonly found in stratum C elsewhere at the Merrell Locality.

In Excavation Area Es, the lowest gravels (indicating the potential presence of fossils derived from stratum C) occur in level 19 (180-190 cm [71-75] b.s.). Above this, in level 7, a right calcaneum referable to muskrat (*Ondatra zibethicus*) was recovered (Dundas, this report). From about level 14 and below (at depth > 140 cm [55 in] b.s.), most faunal remains can probably be attributed to various sedimentary facies of stratum B or the uppermost part of stratum A, although some rodent burrows are also present. The lower, more organic-rich facies of stratum B was en-

countered within Es level 23 (220-230 cm [87-90 in] b.s.). Pockets of what was apparently the uppermost part of stratum A were also encountered at this level. Es level 25 (240-250 cm [94-98 in] b.s.) also contained a muskrat tooth (*Ondatra zibethicus*, Dundas, this report). In Es levels 26 (250-260 cm [98-102 in] b.s.) and 27 (260-270 cm [102-106 in] b.s.), sediments characteristic of stratum A (sandy facies) and stratum B (fine-grained clastics noticeably darker due to higher amounts of organics) were encountered. Thus, fossil remains from these levels could be from the older stratum A or younger stratum B.

Excavation Area J

During the 1995 season, the southern portion of Excavation Area Jsw (sw121N/125E) was excavated as part of a backhoe trench for stratigraphic studies (Figures 11 and 23). The stratigraphy at this location is presented in Figure 27 (after Hill, this report). The north half of Jsw and all of Jnw (sw122N/125E) were excavated by levels in controlled intervals. The 1995 studies of Excavation Area J began approximately at the top of the upper facies of stratum B, although portions of stratum C were also present. Bones were recovered from levels 1 and 2 (bones J1-12 are at depths of 2,009.26 to 2,009.11 masl [ca. 6,592.06-6591.57 fasl]). These include unidentifiable bone fragments as well as limb and rib bones comparable to mammoth recovered at elevations ranging from 2,009.16 and 2,009.21 masl (ca. 6,591.73-6591.90 fasl) (J4, J8, and J12, Dundas, this report). These mammoth remains were likely recovered from the lowest part of stratum C or the upper part of stratum B.

The darkest sediments of stratum B were primarily encountered in levels 2 and 3. Bones appeared to occur in clusters within the darker sediment. Level 3 bones (J13-17) are at elevations between ca. 2,009.11 and 2,009.16 masl (ca. 6,591.57 and 6,591.73 fasl) and include a possible limb bone of a mammoth at an elevation of 2,009.11 masl (ca. 6,591.57 fasl) (J13), as well as unidentifiable fragments of a large mammal limb bone (J16, Dundas, this report). The mammoth limb bone can be fairly confidently attributed to the lowermost, organic-rich lithofacies of stratum B.

Level 4 in excavation Jnw was mostly within the sandy top of stratum A and contained some bones at elevations of 2,009.12 and ca. 2,009 masl (ca. 6591.60 and 6591.20 fasl). Two pieces of a possible mammoth rib (J19, Dundas, this report) were recovered from the top part of stratum A (elevation 2,008.995 masl [ca. 6,591.2 fasl]). Bones J1-J4, J5, J9, J10, J11, J15, J17, and J18 recovered from Jnw were unidentifiable (Dundas, this report).

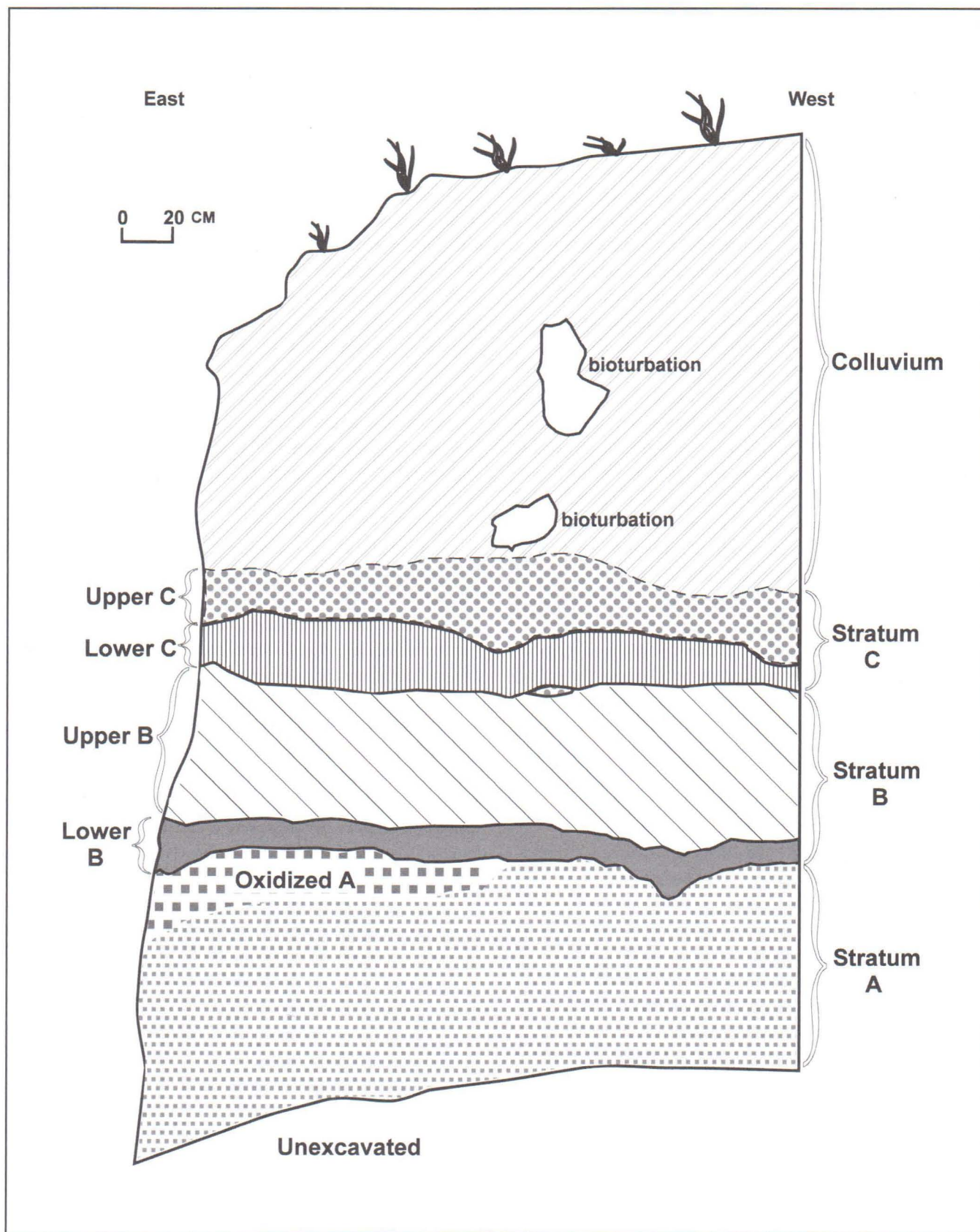


Figure 27. General stratigraphy at east end of backhoe trench, South Block (C. L. Hill profile).

Excavation Area K

Excavation Area K was studied in 1995 and 1996. In 1995, both Ksw (sw123N/125E) and Knw (sw124N/125E) were excavated. Bones were recovered at depths ranging from 2,009.26 to 2,008.99 masl (6,592.06-6,591.17 fasl). Sediments above the darkest facies of stratum B contained fossils in Excavation Area K. Bones were found along the interface of strata B and A (Figure 24) at elevations of 2,009.01 masl (6,591.24 fasl) and ca. 2,009.13-2,009.15 masl (ca. 6,591.60-6,591.70 fasl) (K1 and K2 [a rib fragment referable to mammoth, Dundas, this report]). Mammoth rib fragment specimen K2 was found along the interface between lowest stratum B and the top of stratum A at an elevation of 2,009.13 masl (6,591.63 fasl).

Other bones possibly referable to mammoth (Dundas, this report) were found at the base of stratum B (including K3, a mammoth rib fragment, at an elevation of 2,009.16 masl [6,591.73 fasl]). Limb bone, rib, and tusk fragments probably of mammoth were recovered from the 1995 excavation of K. Specimens K9, K19, K22, K23, and K29 were identified as mammoth, while specimens K4, K6, K13, K17, K21, and K27 are possible or probable mammoth remains (Dundas, this report, Appendix D; MS-767). Knw levels 1 and 2 contained an accumulation of tusk fragments, and level 5 contained a possible fragment of a mammoth phalange (Dundas, this report). Other bones could be identified only as belonging to a large mammal (specimens K12, K15, K20, and K24). Bones recovered in levels 1-4 are probably mostly from the dark, lowermost facies of stratum B, although the top of stratum A began to be uncovered during excavations in level 4. Presumably, bones recovered from the 1995 K level 5 can be attributed to the uppermost part of stratum A.

A single 17-cm-thick level of Knw (sw124N/125E) was excavated in 1996 (Batten and Davis 1996). Tusk fragments (FS142, Dundas, this report) were recovered within this excavation level of Knw (level 1) at an elevation of 2,008.79 masl (ca. 6,590.51 fasl). This is part of the same bone concentration found in level 5 (124N/124N) of Excavation Area Sne (FS143). These and other tusk fragments (FS143) recovered through screening (not found in situ) are attributed to mammoth. They were likely recovered from the darkest-colored facies of stratum B (lowest stratum B).

Excavation Area L

A small portion of Lsw (sw125N/125E) excavated in 1995 contained tusk fragments derived from the lower, organic-rich facies of stratum B (specimen L2) (Figures 23 and 24).

The west half of Excavation Area L was studied in 1996 (Batten and Davis 1996). Two types of sediments were

found within levels 1-5 of Excavation Area Lsw (sw125N/125E). Within the 48 cm of exposed sediments, coarser sediments (silty sands, a facies variant of stratum C), generally tan in appearance, dominate the higher levels. Dark red (generally reddish brown) finer sediments, typically associated with an upper facies of stratum B, occur along the west side of the excavations in levels 1 and 2 and dominate levels 3 and 4. Sediment samples collected from level 3 are primarily representative of stratum B (FS38, FS41, and FS66). Unidentifiable bones mapped in place within the brown sediments include FS31 (level 1); FS34 (level 2); and FS39, FS40, FS42, FS65, FS67, FS69, FS71, FS73, and FS75, all from sediment matrix sample FS86 (level 4). Tusk fragments recovered from levels 3 (ca. 2,009.15 masl) (FS36, FS37, FS63) and 4 (ca. 2,009 masl) are likely derived from part of stratum B (as indicated by matrix sample FS38). Bones found in the "dark red clay" may be in the lower facies of stratum B. They were mapped in place in level 3 (FS36, FS64). This dark clay contrasts with a "light brown silty sand" containing many unidentifiable bone fragments which seemed to have been recovered from the top part of stratum A.

In Excavation Area Lnw (sw126N/125E), five levels forming a 49-cm-thick (ca. 19-in-thick) sequence were excavated in 1996 (Batten and Davis 1996). The first four levels show a heterogeneous mixture of brown sandy silts (fine clastics) and clayey sands (coarse clastics) higher in carbonates. The coarser calcareous sediments dominate levels 2 and 3, but brown sandy silts (fine clastics) dominate levels 4 and 5. The coarser sediments may be part of a facies of lower stratum C, while the brown silts may be a facies of stratum B. The only identifiable faunal remains consist of tusk fragments recovered in levels 3 and 4 (ca. 2,009.95 masl [6,594.32 fasl]). These levels appear to have contained deposits from lower stratum B and uppermost stratum A. Matrix sample FS87 from Excavation Area level 4 consists of sediments associated primarily with stratum B, with some sediment from stratum A.

Excavation Area M

Sediments were exposed in the west half of Excavation Area M during the 1996 season (Batten and Davis 1996) (Figures 24 and 25). Studies of Excavation Msw (sw127N/125E) exposed a 44-cm-thick (17-in-thick) sedimentary sequence (Batten and Davis 1996). Three sediment types were observed at the top of the sequence. Levels 1 and 2 contain light gray mixed sands, more organic-rich sediments, and "transitional" sediments. The organic-rich sediments are perhaps variants of the lower facies of stratum B, while lighter-colored "transitional" sediments observed are perhaps an upper facies variant of stratum B. The light

gray sands seem to be lower stratum C deposits. Thus, the bone collections from these levels probably contain a mixture of fossils from various strata. Two stratigraphic profiles are available for Excavation Area M. A profile depicting the stratigraphy along the South Wall (127N/125.80E to 127N/125E) indicates that stratum C or upper, lighter colored stratum B dominated all but the lower part of level 1. The darker, organic-rich facies of stratum B was observed at the base of level 1 and in the upper part of level 2. Stratum A was present in about the lower third of level 2 and continued in levels 3 and 4. The only identifiable fossil recovered was a fragment of rugose coral from level 3, which could indicate a correlation with stratum A. The coral fragment is interpreted as a redeposited "bedrock" inclusion in the locality's sedimentary matrix.

Excavation Area Mnw (128N/125E) consisted of a 44-cm-thick (17-in-thick) sequence (Batten and Davis 1996). The boundaries of the deposits appear to dip toward the north as indicated by a profile depicting the stratigraphy of the West Wall of Excavation Area M from 128N/125E to 129N/125E. In this part of Excavation M, level 1 and the north part of level 2 and parts of level 3 were composed of either stratum C or lighter-colored sediments from the upper part of stratum B. The dark facies of stratum B was first observed on the south side of level 2 and the top surface of this deposit dips northward near the base of level 3. Thus, level 3 probably contains a mixture of strata A-C. Level 4 contains stratum A and, in the north, stratum B. Level 5 appears to consist of only stratum A. Levels 1, 2, and parts of 3 contain what appear to be lithofacies variants of stratum C. Long bone fragments recovered from level 1 were unidentifiable (FS3, Dundas, this report). Level 3 contains both gravels and oxidized sands and silts (without bones) and, based on the profile, must be the equivalent of stratum A. The top of stratum A typically is composed of sand, but, on occasion, the sandy matrix contains isolated gravel-sized particles. Level 3 also contained darker-colored sediments with bones (possibly a facies of stratum B). The dark-colored sediments are found only in level 3. Tusk fragments recovered from the silty sands in level 4 (FS23, Dundas, this report) can be presumed to be from the top of stratum A. No fossils were recovered from level 5, which would also appear to represent excavations within stratum A.

Excavation Area N

Excavation Area N was studied in 1995. Materials recovered from levels 1-7 are probably attributable to stratum C (Figures 23 and 25). Tusk fragments (N1, Dundas, this report) recovered at an elevation of 2,009.5 masl (6,592.85 fasl) from level 1 seem to be from this deposit.

Excavations in level 2 recovered small shell fragments. In Nsw (sw129N/125E) level 2, a fish vertebra (Pisces) and the right dentary of a sagebrush vole (*Lemmiscus curtatus*) were recovered, along with fragments of enamel referable to mammoth (*Mammuthus*). A skull fragment of fish (Pisces) was recovered from Nnw (sw130N/125E) level 1 (Dundas, this report). Level 4 yielded the distal end of a proximal phalanx referable to horse (*Equus* sp., Dundas, this report), but no shell. Small bone fragments were found throughout, with a few shells recovered in level 6. All of these specimens seem to have been recovered from stratum C.

The most organic-rich facies of stratum B was observed at the top of level 8 (at elevations ca. 2,008.90 masl [6,590.88 fasl]). Bones or teeth of large mammals (FS3-8, Dundas, this report) were recovered from organic-rich sediments at elevations from 2,008.86 to 2,008.75 masl (ca. 6,590.75-6,590.38 fasl) (Figure 25).

The top of stratum A was excavated within level 9 and was devoid of bones.

Excavation Area O

The 1995 work in Excavation Area O indicated that shell fragments of bivalves and gastropods were common in levels 1-4 which were, primarily, lower deposits of stratum C (Figures 23 and 25). Figure 25 shows the location of bones recovered at elevations ranging from 2,009.84 to 2,009.14 masl (ca. 6593.96-6,591.67 fasl). These include gastropods found in situ as well as fragments of bones. A left distal humerus referable to frog (cf. *Rana*) was recovered from Osw level 3 (Dundas, this report). A fragment of Paleozoic coral was also recovered from stratum C.

The generally reddish-brown silts of the upper facies of stratum B were observed first in level 4. Levels 4-7 consist primarily of sediments associated with the upper, lighter-colored ("redder") facies of stratum B. None of the in situ mapped vertebrate remains from Excavation Area O were identifiable (Dundas, this report).

The darkest facies of stratum B was 10 to 20 cm (4-8-in-thick) in Excavation Area O; it was excavated as level 8. Bone appeared to have been concentrated in the lower part of this facies. Fragments of shells were recovered from this level. The interface between lowest B and highest A was used to separate levels 8 and 9.

Level 9 consisted mostly of the sands of the top part of stratum A and contained no identifiable fossils.

Excavation Area P

During 1995, sediments of stratum C from Excavation P were mostly removed by backhoe (Figures 23 and 25). Measured level excavations in Excavation P (sw133N/

125E) were begun starting near the top of the darker-colored sediments of stratum B, although the level 1 collection might contain fossil specimens recovered from the lower deposits of stratum C. Bone was recovered in situ at elevations of ca. 2,009.48 and 2,009.5 masl (ca. 6,592.78-6,592.85 fasl): (P1, an ungulate limb bone fragment, Dundas, this report) and 2,008.87-2,008.83 masl (ca. 6,590.78-6,590.65) (P2, unidentifiable). Tusk fragments recovered from Excavation Area Pnw levels 2 and 3 as well as Psw level 4 can all be attributed with some certainty to the lowermost dark facies of stratum B, as can a skull fragment of a large mammal recovered from level 3 (P3, Dundas, this report). Level 5 is mostly the top of stratum A, although some sediments from stratum B were also observed.

Excavation Area S

Excavations during 1995 recovered fragments of bone, all probably from the lower part of stratum C (Figures 23 and 24). The bones clustered at two elevations: 2,009.72-2,009.77 masl (6,593.57-6,593.3 fasl) (P1-3, including a possible metapodial fragment of a large artiodactyl, cf. Dundas, this report) and ca. 2,009.52-2,009.53 masl (ca. 6,592.91 fasl) (including rib fragments, bones P4-6, all unidentifiable to a particular animal taxon, Dundas, this report). The horizontal location of these specimens from stratum C is shown in Figure 24.

The 1996 studies of Excavation Areas Sse and Sne started at an elevation of ca. 2,009.59 masl (ca. 6,593.14 fasl) and continued to a depth of 2,009.04-2,009.04 masl (6,591.34-6,591.34 fasl) (Batten and Davis 1996). Two types of sediments were observed within the interval containing levels 1 and 2. The apparent base of stratum C was observed, as were lower stratum B darker-colored sediments high in organics and fragments of fossils.

In Excavation Area Sse (sw123N/124E), bones recovered from level 2 (FS25) and level 3 (FS26-29, FS54) are primarily from stratum B. Matrix samples FS27 and FS28 from level 2 are composed of stratum B. This includes tusk fragments (FS28). Fossils collected from levels 4 and 5 (FS92, FS98) could be from either organic-rich stratum B or the underlying sands of stratum A.

In Excavation Area Sne (sw124N/124E), specimens FS107 and FS113 (tusk fragments from level 2) are apparently from stratum C sediments (or perhaps an upper, lighter-colored facies of stratum B), while level 3 tusk fragments (FS124) appear to be most likely connected with the lowermost organic facies of stratum B. Most of the tusk fragments from level 4 are also presumably from the base of stratum B (FS139) as are specimens recovered in the northeast part of quadrant Sne (sw124N/124E) (FS141,

see also FS142 from level 1 sw124N/125E). Tusk fragments recovered in levels 5 and 6 (FS140, FS141) are most likely derived from the top of stratum A.

Excavation Area T

In 1995, bone was recovered in Excavation Area T from what appear to be stratum C deposits overlying stratum B at depths of 2,009.39 and 2,009.43 masl (6,592.49 and 6,592.62 fasl) (Figures 23 and 24). All bones mapped in situ (T1-6) were medial sections of rib fragments from a large mammal (Dundas, this report). The bones formed a small cluster slightly southwest of coordinate 127N/125E (Figure 24).

In the 1996 excavation of Tsw (sw125N/123E), two levels exposed a 71-cm-thick sequence (Batten and Davis 1996). The upper sediments in the sequence were excavated as level 1 and an unidentifiable bone fragment was recovered (FS145, Dundas, this report). At the base of level 2 (ca. 2,009.25 masl [6,592.03 fasl]), Batten and Davis 1996), the higher organic content lower facies of stratum B was collected (FS152), and an unidentifiable bone was found in situ (FS151, see Figure 24).

In Excavation Area Tse (sw125N/124E), three levels were studied in a 54-cm-thick (21-in-thick) sedimentary sequence (Batten and Davis 1996). Each level contained a mixture of sediment types and fairly high concentrations of bone fragments. Fragments recovered in the level 1 tan silty sands and finer dark reddish brown sediments (probably the base of stratum C and upper facies of stratum B) include bivalves, molluscs, and tusk (Dundas, this report, FS91). On the basis of other observations, it may be reasonable to place the molluscs and bivalves within stratum C and the tusk fragments within stratum B, although mammoth remains were recovered from stratum C in Test Pit/Excavation Area E. Darker-colored, fine-grained sediments in level 2 are probably mostly from the lower facies of stratum B (FS117-123, FS129). These include fragments of tusk, some (FS120 and 122) recovered in situ (Figure 24) in what seems to be the lower facies of stratum B (FS122) matrix. More tusk fragments were collected from Tse (sw125N/124E) in level 3 (FS138), apparently from near the base of stratum B.

A 81-cm-thick sequence (three levels from 2,009.91 to 2,009.10 masl [6,594.19 to 6,591.53 fasl]) (Batten and Davis 1996) was exposed in Excavation Area Tnw (sw126N/123E). The presence of silty clay is documented in the nw corner of level 1, with some organic-rich sediments (stratum B) in level 2. By level 3, most of the deposits encountered were high in organics, with some sands present. Level 3 contained relatively large amounts of unidentifiable bone (FS154) along with tusk fragments

(FS156) presumably accumulated within stratum B, perhaps near the base of stratum B along the interface with the upper surface of stratum A (see matrix sample FS153).

In Excavation Area Tne (sw126N/124E), a 57-cm-thick sequence was separated into four levels ranging in elevation from 2,009.42 to 2,008.85 masl (6,592.58 to 6,590.71 fasl) (Batten and Davis 1996). Level 1 contained calcareous sediments with Fe stains (likely a facies of stratum C) as well as organic-rich sediments (stratum B). Unidentifiable bone fragments were recovered from stratum C. Figure 28 depicts level 2, showing the presence of stratum A and stratum B sediments. Organic-rich sediments of stratum B with unidentifiable fossils (FS55, FS79, FS90)

are underlain by gray sandy sediments of stratum A. Stratum A contains tusk fragments (FS61, FS80, FS81) that were mapped in situ at elevations of 2,009.07-2,009.06 masl. Other tusk fragments were recovered as part of the general collection from level 2 (FS62). Decomposed fossil fragments, including some possible mammoth tusk pieces, were also found in level 3 (FS136, Dundas, this report) which would likely be the top of stratum A. Unidentifiable bone recovered in situ from level 4 is also presumably from the top part of stratum A (FS103), since matrix sample FS104 appears to consist of sediments found along the strata A-B boundary.

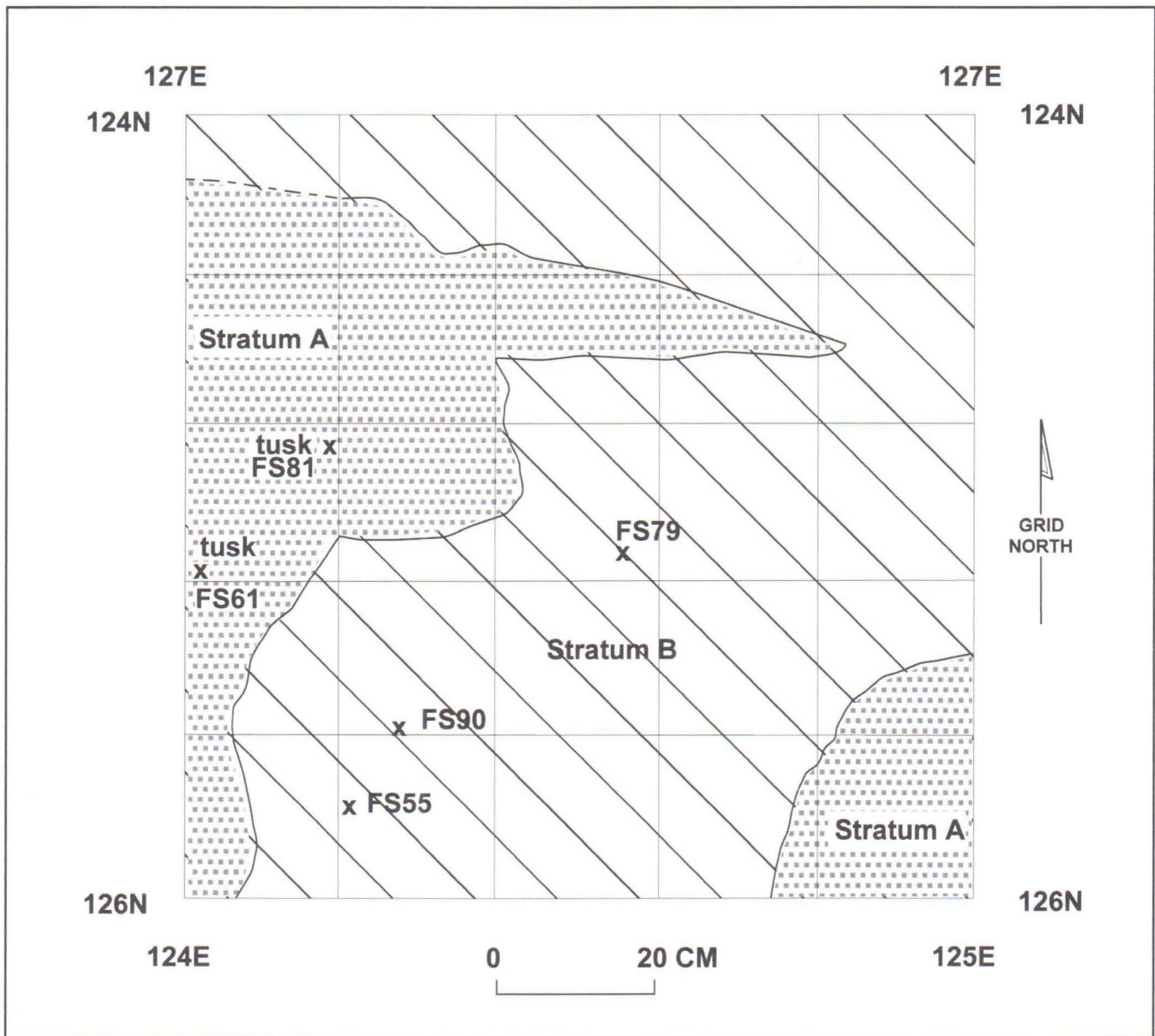


Figure 28. Plan view of Excavation Area T, showing relationship of strata A and B and fossils, South Block (compiled by C. L. Hill).

Excavation Area U

During the 1995 field season, in situ bones were recovered along the south side of Excavation Area U (sw127N/123E). They are plotted on Figure 25 (U1-5). The assemblage consists of two groups of bones at slightly different elevations. Specimens U1 and U2 at 2,009.25-2,009.28 masl (6,592.03-6,592.12 fasl) were unidentifiable bone fragments, and specimens U3-5 at elevations ca. 2,009.36-2,009.37 masl (6,592.39-6,592.42 fasl) were either unidentifiable or rib fragments of a large mammal (Dundas, this report).

All four quadrants of Excavation Area U were studied in 1996. A 37-cm-thick (15-in-thick) sequence was exposed in Excavation Area Usw (sw127N/123E) (Batten and Davis 1996). Unidentifiable bones of level 1 (starting elevation 2,009.96 masl [6,594.36 fasl]) were mapped as FS126 (Figure 25) within gray-colored, fine-grained sediments. These lie above the organic-rich facies of stratum B observed in level 2. Unidentifiable bones were present in this organic-rich deposit (FS148), which was underlain by gray sands of stratum A. In level 3, bones were recovered from both the organic-rich sediments of stratum B and the uppermost light gray sandy deposits of stratum A. The highest concentration of bone fragments was at the very base of stratum B and within the top part of stratum A in Usw (sw127N/123E). These include tusk fragments, some mapped in situ (cf. FS159, elevation 2,008.94 masl [6,591.01 fasl]). Sedimentary matrix from FS159 appears to consist mostly of stratum A with some stratum B.

The 1996 studies of Excavation Area Use (sw127N/124E) consisted of five levels ranging from 2,009.33 to 2,008.76 masl [6,592.29-6,590.42 fasl], for a total thickness of 57 cm (22 in) (Batten and Davis 1996). The darker, organic-rich facies of stratum B was visible in the south and west portion of levels 1-3. Most of the sediments in these levels consisted of Fe-stained, calcareous sediments perhaps related to stratum C. Tusk fragments were recovered from level 3 (FS57). Sands observed in levels 3 and 4 are probably the top part of stratum A which characterizes level 5. Level 4 contained tusk fragments (FS5). Stratum B (lower dark facies) was present in the north half of the excavation in level 4, but disappeared near the top of level 5. Overall, the intervals of excavation appear to contain a heterogeneous mixture of sediment types. This implies that bone specimens collected from any excavation level could be derived from more than one stratum.

Unw (sw128N/123E) was excavated in three levels, exposing a 67-cm-thick sequence. Level 1 and part of level 2 appear to be sediments from above the dark-colored facies of stratum B. Most of level 2 is the stratum B organic-rich deposit. Level 2 contained tusk fragments, some of

which were mapped in situ (FS146, elevation 2,009 masl [6,591.21 fasl], and FS132). Level 3 apparently corresponds to stratum A sandy clays and also contained fragments of tusk (FS133).

Four levels were excavated in Une (sw128N/124E), exposing a 54-cm-thick (21.26-in-thick) sedimentary sequence (Batten and Davis 1996). Levels 1-3 contain sediments and unidentifiable fossils (FS96) above the dark organic zone of stratum B. Level 3 contains both this darker part of stratum B and sandy clay sediments (most likely uppermost stratum A). Bones recovered in level 3 were unidentifiable (FS97). Bones found in only the dark organic zone of stratum B in level 4 were also unidentifiable (FS99, Dundas, this report).

Excavation Area V

The 1996 field studies of Excavation Area V exposed 90 to 102 cm (35 to 40 in) of sediments in three levels (Batten and Davis 1996) (Figure 25). In Excavation Area Vsw (sw129N/123E) level 1, grey clayey sediments, apparently of stratum C, overlie the organic-rich facies of stratum B. The top of this organic-rich stratum is in level 1 and it dominates level 2. The underlying sediments of stratum A were also exposed in the southwest corner of the excavations. Thus, level 2 contains sediments above the organic-rich facies of stratum B, the high-organic zone of stratum B, and sands of stratum A directly below stratum B. Unidentifiable bone fragments (FS134) were recovered in situ from within or at the base of the organic-rich deposit in level 3. Level 4 consists of sandy silts, presumably from the top of stratum A, and contained some fossils (FS131).

In Excavation Area Vse (sw129N/124E), level 1 was more than 70-cm (28-in) thick and was composed of sediments above the distinct organic-rich deposit of the lowermost facies of stratum B observed in level 2. Level 2 contained some tusk fragments (FS83). Level 3 was composed mostly of sandy clay (likely a facies of stratum A) underlying stratum B.

Excavation Area Vnw (sw130N/123E) contained light-colored sediments in level 1. These upper sediments were followed by dark-colored sediments (stratum B) in levels 2 and 3 with mapped in situ unidentifiable bones (FS105, FS111, FS115/116). Unidentifiable bones FS110 and FS114 seem most likely to also be derived from the dark organic facies of stratum B.

Within Excavation Area Vne (sw130N/124E), the lower portions of gray (stratum C?) and reddish (stratum B, upper facies?) sediments were found above the more organic-rich facies of stratum B in level 1. Level 2 contained mostly the lowermost organic-rich facies of stratum

B, but also the uppermost part of stratum A (FS16, FS58). All fossils in level 2 were unidentifiable. However, FS16, recovered in situ from the lowermost facies of stratum B (as indicated by matrix sample FS17) at an elevation of 2,008.74 masl (6,590.35 fasl), may be a fragment from a mammoth, based on size (see Dundas, this report). Level 3 consisted of only stratum A and apparently contained no fossils.

Excavation Area W

The 1996 excavation within the east portion of W exposed a 96-97-cm (ca. 38-in)-thick sediment sequence (elevations range from 2,009.62 to 2,008.6 masl [6,593.24 to 6,589.89 fasl], Batten and Davis 1996: Table 1) (Figure 25). Excavation of Wse (sw131N/124E) level 1 exposed tan and gray sediments directly above the dark facies of stratum B. The organic-rich portion of stratum B was also well-defined and two bones were recovered at the base of the level (the bones were mapped in place, but were unidentifiable) (FS7, FS9, Dundas, this report). Level 2 consisted primarily of the darker-colored facies of stratum B (bones for the entire level are FS46, all unidentifiable). Two in situ unidentifiable mapped bones (FS10, FS18) were recovered in the grid southeast part of the excavation of level 2. Sediments from the top of stratum A, underlying the darker sediments of stratum B, were found in level 3. On the west side of this level, bones were found and mapped in situ (FS47/48, FS49/50), although none were identifiable (Dundas, this report).

Excavation Area Wne (sw132/N124E) level 1 contained grey and Fe-stained sediments (apparently lower stratum C deposits) and some dark organic deposits (a facies of stratum B, as indicated by matrix sample FS8). The darkest part of stratum B (represented by matrix samples FS10, 19, and 57) was excavated as level 2 (it contained unidentifiable bone fragments, FS45). The boundary between stratum B and the underlying sediments of stratum A was encountered in level 3. Tusk fragments (FS51, FS52, FS59) from level 3 are likely from stratum A, although matrix samples collected from this level also contain stratum B sediments (FS48, FS50, FS52).

Excavation Area X

Excavation Area X was first studied in 1995. A small basin was clearly delineated by an erosional surface along the interface separating sands of stratum C and lower deposits which include stratum B (Figure 25). Bones were discovered in situ during the excavation of stratum C. Most of the 17 bones mapped in situ were unidentifiable, except for X7 (*Canis latrans*). Bone X2 might be a rib fragment from a large mammal, X6 a possible metapodial from a large artiodactyl, X8 a limb bone fragment from a large mammal, X16 a partial podial of a large mammal, and X17 fragments from a large herbivore limb bone (Dundas, this report). The horizontal relationships of these bones is shown in Figure 29, based on data collected by D. Batten. Tusk fragments were recovered from water-screened sedimentary matrix from Excavation Area X.

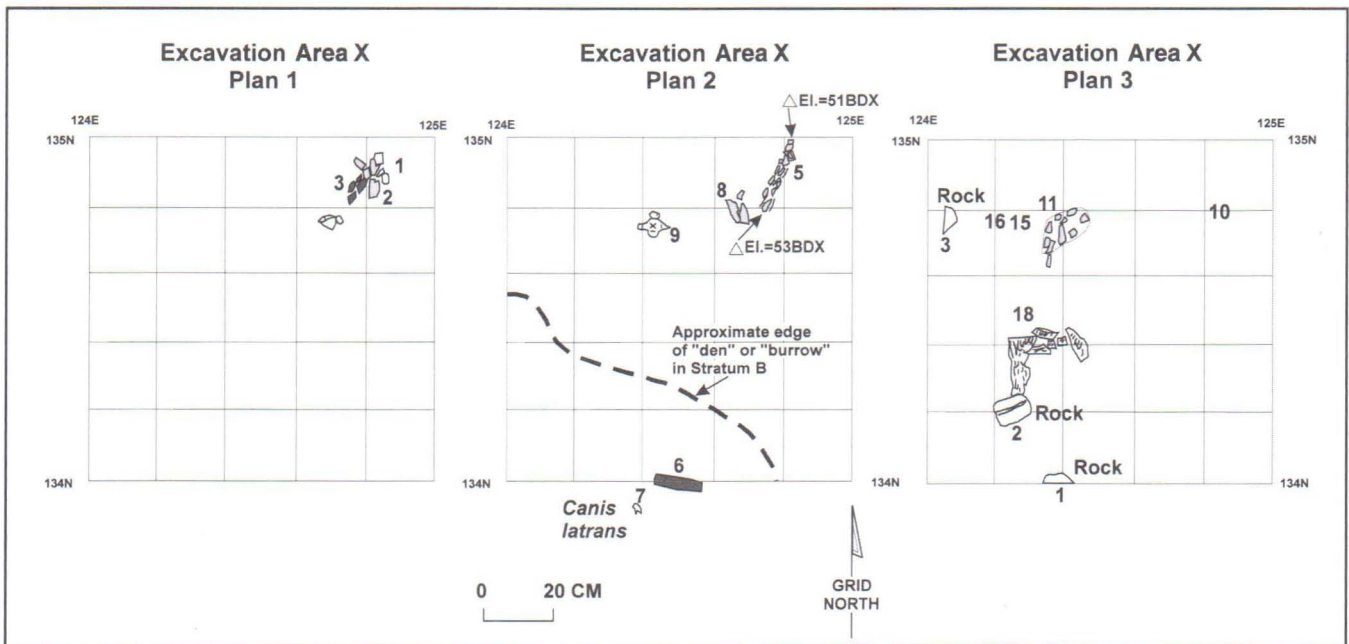


Figure 29. Plan view of Excavation Area X, South Block (data from D. Batten, compiled by C. L. Hill).

In 1996, two additional levels were studied at Excavation Area Xse (sw133N/124E), exposing a 53-cm-thick (21-in-thick) sequence (elevations ca. 2,009.15-2,008.62 masl [6,591.70-6,589.96 fasl]; Batten and Davis 1996). Level 1 consisted of sediments above the darkest part of stratum B, while unidentifiable bone material (FS84, Dundas, this report) recovered from level 2 can be attributed to the organic-rich facies of stratum B.

Summary

Fossils of Pleistocene fauna, chiefly bones and tusk fragments that can be attributed to mammoth, were recovered from several different geologic contexts in the Merrell Site South Block. The horizontal and vertical distribution of fossils recovered in the South Block area were recorded by one of two procedures. Typically, collections were made of all fossil material found within a specified excavation interval, commonly a measured excavation interval of a 1 x 1-m square ("Excavation Area") aligned along the coordinates of the site grid. Fossils found in situ were mapped. Different specific methodologies were applied in each of the field seasons, and details of the procedures used in each field season are available in the MOR field records and end-of-season reviews (as summarized in Batten, this report).

The horizontal distribution of fossils mapped in place is shown as Figure 23. This map is a compilation of all in situ fossils (identifiable and unidentifiable based on comparative morphology) in planview. The distribution pattern no doubt partially reflects different collection strategies. Nevertheless, some patterns are apparent. There appears to have been a fairly high concentration of mammoth bone fragments on the south side of the South Block, close to the escarpment edge (approximately between 122-126N and 125-126E on the site grid, mostly in Excavation Areas Jsw, Jnw, Ksw, Knw, and Lsw, Figure 24). Identified bones in this area are nearly all mammoth remains, which include fragments of limb bones, ribs, vertebrae, and tusk.

Another fairly high concentration of mammoth remains was present in the grid southwest part of Test Pit/Excavation Area E (ca. 121-122N/123E on the site grid). This was the general location of three mammoth molars as well as tusk and rib fragments.

A more diffuse scatter of in situ fossils was found spread between ca. grid 126-128N, mostly within 124-125 E (mostly in the western portions of Excavation Areas Sse, Sne, Tse, and Tne). The 1995 in situ remains from this area were largely unidentifiable.

Another moderately dense scatter of fossils was mapped in situ in the vicinity of Excavation Area Xne. A fragment of a coyote (*Canis latrans*, MOR-LI95.2.309) tooth and an ungulate bone were recovered in place in this area.

The vertical locations of fossils found in situ are known with some precision, and the elevations of the fossils recovered in general context are known within the vertical thickness of the excavation levels. Here, again, the thickness of the excavation interval and the means of collection varied during the three seasons of field studies and any potential patterns should be interpreted within the constraints of this variation. In some instances, the excavation intervals conform closely to geologic strata or are intervals mostly within a well-defined geologic deposit. For example, excavators were commonly able to discern the organic-rich facies of the lower part of stratum B and the underlying sands or sandy clays of the top of stratum A. However, even in the instance of the organic-rich dark deposit of stratum B, it is apparent that some excavation intervals that contained it also included portions of stratigraphically higher or lower deposits. This was due at least in part to the fluctuating thickness and changing elevations of the deposits. Some of the excavation levels contained fossils found within at least two distinct geologic deposits, and sometimes perhaps more. Elevational control in-and-of-itself appears to be of only limited value because of extreme postdepositional alteration (faulting, liquefaction, bioturbation) that has deformed the deposits.

Despite these constraints, it is possible to attribute specific fossil specimens recovered from the South Block excavations to particular strata. In terms of taphonomic considerations, it would seem prudent to remember that the presence of fossils within a particular geologic deposit does not necessarily lead to the inference that the fauna associated with these remains were living contemporaries of the environment of deposition. What can be inferred is that the fossils are the remains of animals that lived either at about the same time as the sedimentational event that incorporated them into the deposit (where they were recovered) or that they lived at an earlier time.

During the MOR excavations of the South Block, fossils were recovered from the top of stratum A, along the interface between the top of stratum A and the base of stratum B, within stratum B (apparently often near the base of the darkest, most organic-rich facies of the lower part of stratum B), and also in stratum C. Postdepositional horizontal and vertical movement of the sediments and disturbance of the fossils within these deposits appears to have influenced the final spatial patterns. Remains of mammoth found in the Merrell South Block were recovered

along the interface of stratum A and stratum B, often within the base of stratum B, but also in contexts where they could have originally been within the top of stratum A. This is the pattern along the southeast side of the South Block near the escarpment as well as in Test Pit/Excavation Area E. Other bone concentrations can, for the most part, be attributed to have been from within or near the base of stratum B and within stratum C with some confidence. For instance, the remains of *Canis latrans* can be attributed to stratum C. Some other fossils were also recovered from stratum C, including *Lemmiscus curtatus*, *Mammuthus* sp.,

and Osteichthyes. These bones, especially when found in the silty (low-energy) facies of stratum C, may be an indication of paleoenvironmental conditions directly associated with the time of deposition. There is a greater chance that fossils recovered within the coarser (higher energy) facies of stratum C have a more complicated taphonomic trajectory. If stratum C reflects predominantly episodic fluvial deposition, then the isolated faunal elements incorporated into these sediments may be older Pleistocene faunal remains redeposited into younger sediments.