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The Fairmead Landfill Locality (Pleistocene, Irvingtonian), Madera County, California: preliminary report and significance

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ABSTRACT

A diverse vertebrate fauna, dominated by large herbivorous mammals, was discovered in May of 1993 at the Madera County Fairmead Landfill in alluvial fan, fan channel and marsh/lacustrine sediments representing the upper unit of the Turlock Lake Formation. Taxa identified from this fauna include: *Clemmys marmorata*, Anatidae, *Glossotherium harlani*, *Nothrotheriops* cf. *N. shastensis*, *Megalonyx* sp., *Canis armbrusteri*, *Canis* cf. *C. latrans*, *Smilodon* cf. *S. fatalis*, *Homotherium* sp., *Thomomys* sp., cf. *Dipodomys* sp., *Lepus* sp., *Mammuthus columbi*, *Equus* sp. (large and small), *Camelops* sp., *Hemiauchenia* sp., *Tetrameryx irvingtonensis*, *Capromeryx* sp., and *Odocoileus* sp. A late Irvingtonian age is indicated for the fauna based largely on the presence of *Tetrameryx irvingtonensis* coupled with the absence of *Bison*. The fossil bearing stratum is normally magnetized, and is inferred to have been deposited during the Brunhes normal magnetic polarity chron, placing an upper bound on the age of the fauna at 780,000 years before present (yr. B.P.). The Fairmead Landfill yields the first diverse latest Irvingtonian fauna from north-central California. Comparison to the older, coastal type Irvington fauna will enhance our understanding of the Irvingtonian of California, permitting better comparisons and correlations with other North American Irvingtonian age faunas.

INTRODUCTION

The Pleistocene of North America is divided into two land mammal ages (NALMAs), the Irvingtonian and the Rancholabrean, typified by California localities. Irvingtonian (early to middle Pleistocene) localities are sparse, in comparison to Rancholabrean (late Pleistocene) sites, and the precise stratigraphic position of many localities within the Irvingtonian is uncertain (Kurtén and Anderson, 1980). The type Irvington fauna occurs in reversely magnetized strata referred to the Matuyama magnetic chron, 780,000+ yr. B.P. (years before present; Lindsay et al., 1975; Kurtén and Anderson, 1980; Baksi et al., 1992). The exact position of Irvington within the Matuyama is questionable, but faunal constituents indicate that it most likely is in the upper portion of the magnetic chron. Until 1993, Irvington was the only diverse Irvingtonian age fauna known from north-central California.

A new fauna from an expansion cell of a landfill south of Chowchilla, Madera County, California augments this limited record. The Fairmead Landfill fauna, occurring in normally magnetized strata referable to the lower Brunhes magnetic epoch, is younger than the type Irvington fauna. Together the Irvington and Fairmead Landfill sites provide a record of the middle to late Irvingtonian of central California, allowing for better comparisons and correlations with other North American Irvingtonian faunas.

To advance our understanding of the Irvingtonian in California a comprehensive study of the newly discovered Fairmead Landfill fauna and a revision of the type Irvington fauna are underway. The latter effort is necessary in order to report significant unpublished data (e.g. Firby, 1968), including many taxonomic records not cited in the literature. As an initial step in this process, some preliminary findings of the Fairmead Landfill locality study are presented here.

SITE LOCATION

The Madera County Fairmead Landfill, located at 21739 Road 19, Chowchilla, California, is about 3.3 km south-southeast of the junction of California state highways 99 and 152. Map coordinates are 37°03'24" N, 120°11'45" W, Berenda, California, United States Geological Survey 7.5" topographic quadrangle, 1987 photorevised (Figure 1). The fossil material was recovered at elevations of about 61-64 meters, which is 11-14 meters below ground surface. Fairmead Landfill is recorded as University of California Museum of Paleontology (UCMP) vertebrate fossil locality V93128.

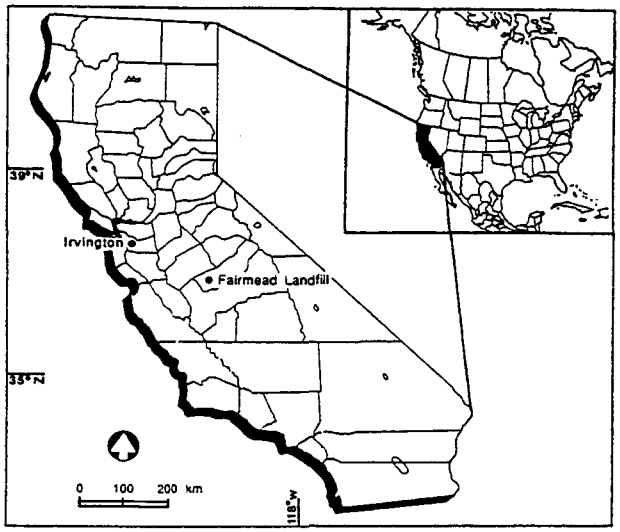


Figure 1. Map noting the locations of Fairmead Landfill, Madera County and Irvington, Alameda County, California. Base map is modified from Fay and Thiessen (1993).

HISTORY OF INVESTIGATIONS

Vertebrate fossils were discovered in May of 1993 during excavation of an expansion cell at the Madera County Fairmead Landfill. Following the initial evaluation of the site, the University of California Museum of Paleontology entered into a short-term, paleontological mitigation contract with Madera County to salvage the exposed vertebrate remains. A five meter square grid system, with alphanumeric coordinates, was used to map the position of excavated fossils. Recovery work began June 7, 1993 and concluded December 31, 1993, yielding thousands of specimens. Fossil recovery by the UCMP ended at Fairmead Landfill in the fall of 1993 following expiration of the mitigation contract between the UCMP and Madera County. Since the fall of 1993 R. G. Dundas has functioned as the professional vertebrate paleontologist monitoring the site to assure compliance with CEQA regulations regarding any future discoveries of fossil material at the landfill. D. L. Blades was hired by Madera Disposal Systems and the County of Madera in the fall of 1993 to act as on-site monitor under the direction of R. G. Dundas. Further landfill expansion from early 1994 to the present time has resulted in intermittent finds of bone. Fossils are removed as they are uncovered during ongoing landfill excavation. The UCMP is the repository for all fossil material from Fairmead Landfill.

GEOLOGY

The Fairmead Landfill is situated on the alluvial fan of the Chowchilla River, about 19 kilometers west of the fan head. The 1993 expansion pit was excavated to a depth of about 14 meters through a sequence of sand, clayey sand, and minor clay which was well-exposed in temporary vertical cuts prior to final beveling of the pit walls. This sequence of distal alluvial fan and fan channel deposits is divisible into three stratigraphic units separated by unconformities and prominent paleosols (Figure 2). These units are designated A, B, and C from the surface downward. The vertebrate remains are from the lower exposed extent of Unit C.

Unit A consists of three to four meters of sand and pebbly sand with small-scale cross-bedding, representing the sandy fill of a former fan channel. The soil developed on Unit A is a yellow-brown sandy loam with a weakly to strongly-cemented iron-silica duripan, characteristic of the Madera soil series of the San Joaquin Valley.

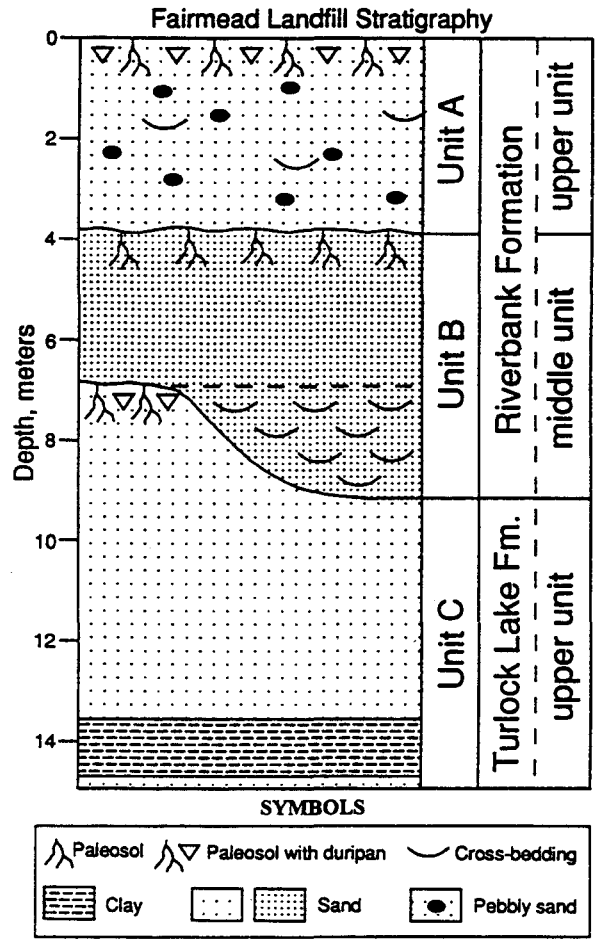


Figure 2. Generalized stratigraphy of the Fairmead Landfill 1993 expansion pit, based on south wall exposures and trenches in the pit floor. Also shown are inferred correlations between locally-defined units (A, B, and C) and the regional Pleistocene stratigraphy of the northeast San Joaquin Valley (right-hand column).

Unit B consists of three to four meters of massive clayey sand which in the western half of the pit overlies a sand-filled channel eroded several meters deeper into the underlying Unit C. The channel-fill consists of medium to coarse sand with pervasive trough cross-bedding, which indicates paleoflow toward the southwest and west. Although the western margin of this channel was not revealed by the 1993 excavation, its dimensions are probably comparable to those of the modern Chowchilla River. The top of Unit B is marked by a clay-rich paleosol overlain by a sharp erosional contact with the clean, unconsolidated sand at the base of Unit A. The Unit B paleosol has a blocky to prismatic structure with pervasive oxide staining of ped surfaces, but lacks a duripan. Pedogenic features persist to a depth of 1.3 m below the top of the unit.

Unit C comprises the lower half of the pit wall on the east side, with a maximum exposed thickness of six to seven meters. Most of the section consists of clayey sands and sands overlying a layer of massive sandy clay and clayey very fine sand which forms most of the pit floor. Abundant vertebrate fossils were found in the basal sandy clay and in the lowermost sand beds (Figure 3).

The sand layers in the upper part of Unit C are tabular and in most cases massive and clayey; layers of clean fine sand with cross-lamination occur locally. The coarser layers (medium to coarse sand) have sharp bases and show normal grading in their upper parts. Rootlet traces are very common in the upper few centimeters of most beds. These features point to rapid but intermittent deposition beyond the confines of active fan channels, probably during overbank flood and sheetflood events.

The sandy clay layer at the pit floor yielded most of the large vertebrate remains. Backhoe trenches revealed that the clay is as much as a meter thick, is cut by pervasive fine rootlet traces, and locally overlies a coarse pebbly sand. *Clemmys marmorata* and Anatidae remains found in the clay indicate the presence of a perenially wet environment, such as a marshy, abandoned fan channel or lake-margin. Many smaller bones in the clay show evidence of breakage *in situ*, and a few are oriented at high angles to the horizontal, both probably as a result of trampling by large herbivores. Floating pebbles in the clay surrounding the trampled bones were most likely mixed upward into the mud from the underlying pebbly sand.

A well-developed paleosol is present at the top of Unit C in the eastern part of the pit, but is absent in the western half owing to erosional downcutting of the channel at the base of Unit B.

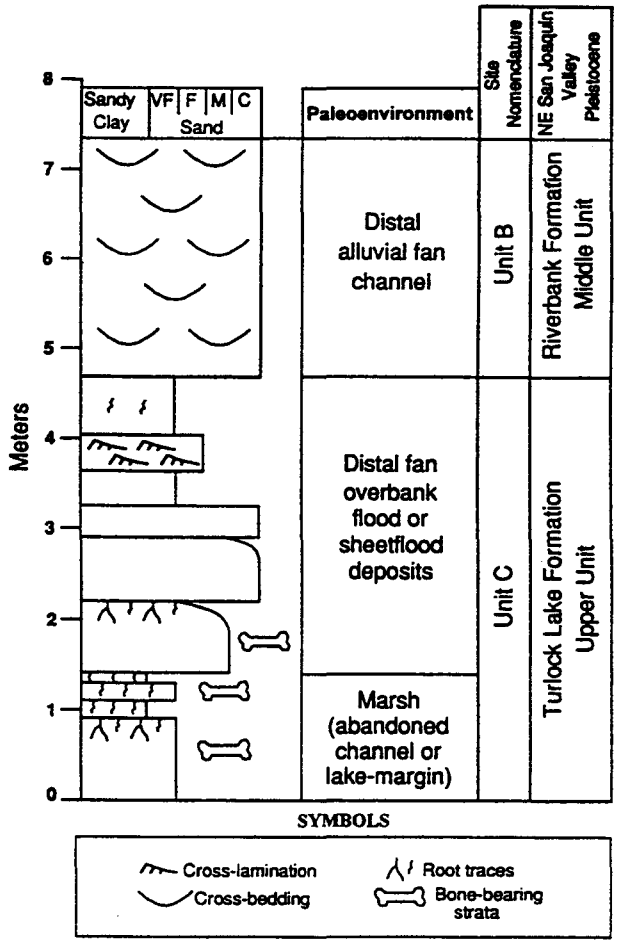


Figure 3. Detailed lithologic section for the lower part of the south wall of the Fairmead Landfill 1993 expansion pit between grid lines 11 and 12, showing inferred paleoenvironments and regional correlations.

The paleosol is clayey and very red in fresh exposures, with a strongly-cemented duripan.

Marchand and Allwardt (1981) mapped and subdivided the Pleistocene alluvial deposits of the northeastern San Joaquin Valley (Figure 4). The deposits exposed on the distal parts of the alluvial fans (such as in the Fairmead area) are subdivided on the basis of differing soil profile development and unconformities associated with buried soils. Their mapping in the area of the Fairmead landfill assigns the surface deposits to the middle unit of the Riverbank Formation, with the upper unit of the Riverbank Formation onlapping from the west and filling channels incised into the middle unit. Over most of the Chowchilla fan, the lower unit of the Riverbank Formation is missing, and the middle unit lies directly on the upper unit of the Turlock Lake Formation, which is locally exposed along incised channels beginning about 5 kilometers northeast of the landfill. In mapping the Pleis-

tocene deposits along the Chowchilla River, Helley (1966) also found that the Riverbank Formation is very thin on the fan east of Chowchilla, but thickens rapidly westward.

Preliminary correlations between the Fairmead sequence and the regional stratigraphy of Marchand and Allwardt (1981) are presented in Figures 2 and 3. We constructed contours on the exposed Riverbank-Turlock Lake contact northeast of Fairmead and used the resulting gradient to project that contact southwestward into the landfill area. Although this procedure is crude, it suggests that the fossil-bearing Unit C, exposed in the lower walls of the Fairmead pit, correlates with the upper unit of the Turlock Lake Formation. The overall thickness of Units A and B (7 to 9 m) at Fairmead accords well with the total thickness of the Riverbank Formation (3 to 7 m) measured by Helley (1966) 6.5 kilometers northwest at Chowchilla, which occupies a similar position on the Chowchilla fan. We suggest that Unit A is a previously unmapped Upper Riverbank channel fill, and correlate Unit B with the middle unit of the Riverbank Formation.

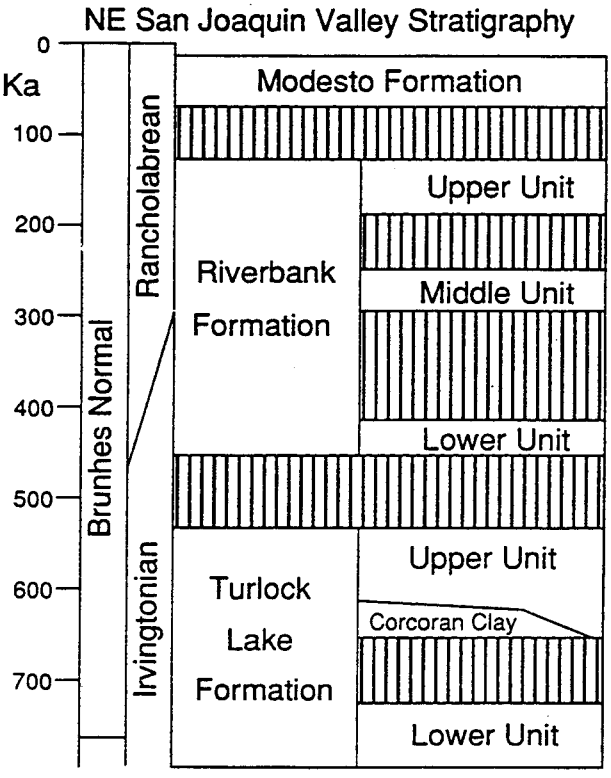


Figure 4. Younger Pleistocene stratigraphic units of the northeast San Joaquin Valley as defined by Marchand and Allwardt (1981).

PALEOMAGNETISM

Samples were collected for paleomagnetic analysis from eighteen horizons in Unit C. Each sample was collected in a small (1.8 cm x 2.0 cm x 2.0 cm) plastic box that was placed over a pedestal of sediment carved on the outcrop. Each box was fully oriented with respect to a geographic coordinate system. The samples were collected at two sites in the Fairmead landfill. The first site was located on the southwest corner of the excavation in the clay layer at the basal exposure of the fossil-bearing bed. There were eight sampling horizons at this site, comprising three groups. The first horizon of the first group represented the lowest exposed level of the clay layer. A second horizon was located 32 cm above the first. The second group of three more horizons, separated by intervals of 16 cm and 14 cm respectively, was located about 0.5 m above the first group. A third group of horizons was located another 0.5 m above the second group. Within this group, the horizons were separated by 18 cm and 13 cm, respectively.

The second site was located on the south wall of the pit. There were ten sampling horizons at this site, and again the first horizon represented the lowest level exposed on the wall. A second horizon was located 30 cm above the first and a third horizon was 25 cm above the second. Another group of three horizons was located about 1.1 m above the highest horizon of the first group. These three horizons were separated by distances of 30 cm and 25 cm, respectively. A third group of two horizons was located another 1.1 m above the second. The two horizons in this group were separated by 30 cm. The final group of horizons began about 2.2 m above the third group. The two horizons in this group were separated by 27 cm. Together the two sites provide a comprehensive sampling of Unit C from its lowest exposed level in the landfill to within 1 meter of its contact with Unit B.

One sample from each horizon was analyzed in the Paleomagnetism Laboratory of the University of California at Davis. Paleomagnetic measurements were made using a 2-G Enterprises Model 760 cryogenic magnetometer. Alternating field demagnetization was done using a Schonstedt SSM-1 demagnetizer. Each sample was demagnetized at 10 different levels of peak alternating magnetic field: 0, 5, 10, 15, 20, 25, 30, 40, 50 and 60 mT. Natural remanent magnetization intensities ranged from 7.6×10^{-3} to 1.4×10^{-1} A/m, although most of

the samples fell in the narrower range of 2.4×10^{-2} to 6.2×10^{-2} A/m. All of the samples were extremely well-behaved during the demagnetization procedure. The remanent magnetic directions of all of the samples decayed univectorially toward the origin. A few samples appeared to have minor secondary components that were removed after the first or second demagnetization step.

Declinations of the samples ranged from 30° W to 20° E. Inclinations ranged from 30° to 62°. These directions are fully consistent with a normal magnetic polarity. Because of the great stratigraphic sampling interval, it is unlikely that these normal polarities represent a short normal subchron in the Matuyama reversed chron. We conclude that the sediments at the Fairmead landfill, and in particular the fossil-bearing interval of Unit C, were deposited during the Brunhes normal polarity epoch. This places an upper bound of 780,000 years on the age of the fossils found at this site.

FAUNA

The vertebrate fossils recovered from Fairmead Landfill represent a diverse fauna dominated by large mammals. Microvertebrate material is rare at this site, but several tons of matrix remain to be processed which may yield additional small vertebrate taxa. The taxa identified thus far are listed in Table 1. These are tentative identifications; further study will permit assignment of some specimens to the species level. The preliminary identifications were made using comparative specimens in the research collections of the UCMP and pertinent literature on each of the taxa. Detailed descriptions of the faunal material are not provided here because much material is unprepared and the fauna is still under study. For reference, voucher specimens for each taxon are provided in Table 2. Selected specimens are illustrated in Plate I.

AGE

The age of the Fairmead Landfill fauna is late Irvingtonian, based on the currently known stratigraphic ranges of species present at the site (Figure 5) and from magnetostratigraphy and geologic data. Most of the taxa have stratigraphic ranges encompassing much of the Pleistocene. In part this is because many of the identifications are only to the genus level. Two species indicate an Irvingtonian age; *Tetrameryx irvingtonensis* and *Canis armbrusteri*. The presence of *Tetrameryx irvingtonensis* is suggestive of a middle-late Irvingtonian age because it is known only from the type Irvington locality in the San Francisco Bay area (Kurten and Anderson, 1980). *Canis armbrusteri* is known from several Irvingtonian age localities in North America and the species became extinct around the Irvingtonian/Rancholabrean boundary (Kurten and Anderson, 1980; Nowak, 1979). Savage (1951) distinguished the Irvingtonian and Rancholabrean NALMAs on

Table 1. Taxa identified from Fairmead Landfill, locality UCMP V93128.

- Class Reptilia
  - Order Testudines
    - Family Emydidae
      - *Clemmys marmorata*
- Class Aves
  - Order Anseriformes
    - Family Anatidae
- Class Mammalia
  - Order Edentata
    - Family Mylodontidae
      - *Glossotherium harlani*
    - Family Megatheriidae
      - *Nothrotheriops* cf. *N. shastensis*
    - Family Megalonychidae
      - *Megalonyx* sp.
  - Order Carnivora
    - Family Canidae
      - *Canis* cf. *C. latrans*
      - *Canis armbrusteri*
    - Family Felidae
      - *Smilodon* cf. *S. fatalis*
      - *Homotherium* sp.
  - Order Rodentia
    - Family Geomyidae
      - *Thomomys* sp.
    - Family Heteromyidae
      - cf. *Dipodomys* sp.
  - Order Lagomorpha
    - Family Leporidae
      - *Lepus* sp.
  - Order Proboscidea
    - Family Elephantidae
      - *Mammuthus columbi*
  - Order Perissodactyla
    - Family Equidae
      - *Equus* sp.
  - Order Artiodactyla
    - Family Camelidae
      - *Camelops* sp.
      - *Hemiauchenia* sp.
    - Family Antilocapridae
      - *Tetrameryx irvingtonensis*
      - *Capromeryx* sp.
    - Family Cervidae
      - *Odocoileus* sp.

Table 2. List of voucher specimens for taxa recovered from Fairmead Landfill, UCMP locality V93128. Abbreviations: R. = right, L. = left, i = lower incisor, dp = deciduous lower premolar, p = lower premolar, P = upper premolar, m = lower molar, M = upper molar.

Taxon	Voucher specimen(s) with element identification
Clemmys marmorata	UCMP 140625, incomplete carapace
Anatidae	UCMP 140414, distal humerus
Glossotherium harlani	UCMP 140263, premolar;
	UCMP 140392, R. dentary
Nothrotheriops cf. *N. shastensis*	UCMP 140260, cranium;
	UCMP 140261, tooth
Megalonyx sp.	UCMP 140262, upper canine;
	UCMP 140393 premolar or molar
Canis armbrusteri	UCMP 140265, partial R. dentary with p1-m2
Canis cf. *C. latrans*	UCMP 140413, L. maxilla fragment with M2-M3
Smilodon cf. *S. fatalis*	UCMP 140426, R. and L. frontal and parietal;
	UCMP 140264, distal fibula, partial L. astragalus
Homotherium sp.	UCMP 140390, partial cranium;
	UCMP 140391, upper canine
Thomomys sp.	UCMP 140408, lower premolar
cf. *Dipodomys* sp.	UCMP 140627, R. i1
Lepus sp.	UCMP 140626, incomplete juvenile R. tibia
Mammuthus columbi	UCMP 140415, R. and L. dentaries with teeth
Equus sp. (large and small)	UCMP 140404, L. dentary fragment with p2-p3
Camelops sp.	UCMP 140400, partial R. dentary with p4-m3;
	UCMP 140401, partial R. dentary with p4-m3
Hemiauchenia sp.	UCMP 140397, partial R. dentary with dp3-m2
Tetrameryx irvingtonensis	UCMP 140398, L. cranial fragment w. horn cores
	UCMP 140410, L. m2
Capromeryx sp.	UCMP 140409, radius
Odocoileus sp.	UCMP 140399, base of R. antler

the basis of the presence of *Bison* in Rancholabrean localities. The absence of *Bison* in a fauna represented by thousands of specimens, and dominated by large herbivores which normally occur with *Bison* in Rancholabrean localities, is further indicative of an Irvingtonian age.

Paleomagnetic analysis suggests a maximum age of 780,000 yr. B.P., the Matuyama/Brunhes boundary (Baksi et al., 1992), for the Fairmead Landfill fauna because the stratum in which the fossils occur is normally magnetized. As a great stratigraphic range was sampled, it is unlikely that the fossil-bearing unit was deposited during the Jaramillo normal subchron within the Matuyama reversed magnetic chron. The Jaramillo normal magnetic subchron and the beginning of the Brunhes normal magnetic chron are the only two major periods of normal magnetism that occur in the late Irvingtonian (Lindsay et al., 1987; Kurten and Anderson, 1980).

DISCUSSION

Savage (1951) originally defined the Irvingtonian NALMA based on the fauna from the gravel pits near Irvington, Alameda County, California. As presently construed, the Irvingtonian begins at about 1.9 Ma and ends between about 0.5-0.3 Ma (Lundelius et al., 1987). The Irvingtonian lacks long, continuous sequences of superimposed faunas such as those represented in the preceding Blancan NALMA. However, some short sequences exist (e.g. Vallecito Creek, San Diego County, California in part). Some localities have paleomagnetic data, while others have datable volcanic ash beds (Lundelius et al., 1987) but in large part Irvingtonian stratigraphy depends on fossil remains. Detailed study of the Fairmead Landfill fauna and revision of the type Irvington fauna should yield a picture of the middle to late Irvingtonian of central California. This will allow for better comparison and correlation with other Irvingtonian faunas in North America, which is the essence of biostratigraphy.

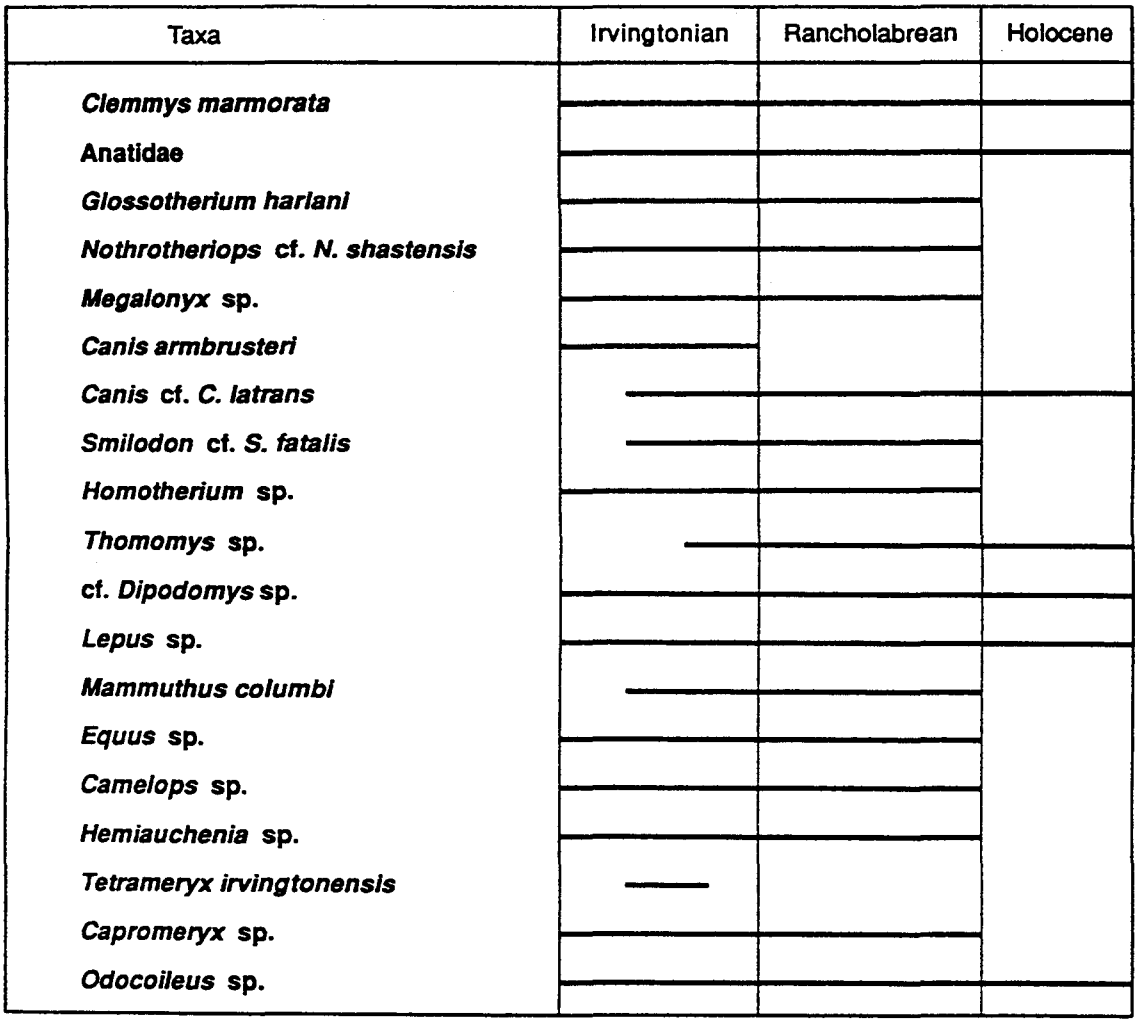


Figure 5. Stratigraphic ranges of Fairmead Landfill taxa. Ranges were compiled from Kurtén and Anderson (1980) and Nowak (1979).

ACKNOWLEDGEMENTS

We express our appreciation to the County of Madera, to Madera Disposal Systems, Inc. and especially to the many volunteers for their time and assistance with excavation. Diane L. Blades deserves special recognition for her efforts, initially as a volunteer, and later as on-site monitor for the excavation from September 1993 to the present time. Volunteers of special note who have contributed significantly to the excavation include: Bill Hamilton, Sam Champion, Wally Nichols, Pam Lara, Mary DiViccaro and John McCormick. Thanks to Art Alejandre, formerly of Madera Disposal Systems, for his assistance throughout 1993 and 1994. The faunal remains were identified by R. G. Dundas, J. H. Hutchison, C. J. Bell and L. G. Nelms. The 1993 UCMP fossil recovery work was supervised by L. G. Nelms, J. H. Hutchison and R. G. Dundas. Subsequent fossil recovery work has been conducted under the direction of R. G.

Plate I. Each specimen illustrated in Plate I has its own bar scale. The bar scale following each letter on the plate is equal to 2 cm.

Figure A. *Canis armbrusteri*, UCMP 140265, a partial right dentary with p1-m2. Lateral view.

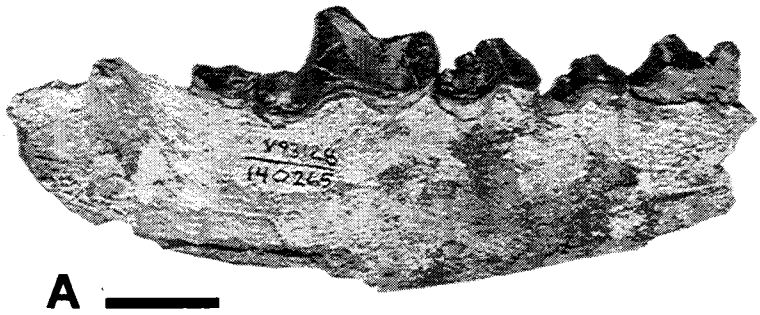
Figure B. *Odocoileus* sp., UCMP 140399, base of a right antler. Medial view.

Figure C. *Tetrameryx irvingtonensis*, UCMP 140398, left cranial fragment with partial horn cores.

Figure D. *Camelops* sp., UCMP 140401, a partial right dentary with p4-m3. Lateral view.

Figure E. *Homotherium* sp., UCMP 140390, a partial cranium. Lateral view.

Figure F. *Homotherium* sp., UCMP 140391, upper canine. Lateral view.



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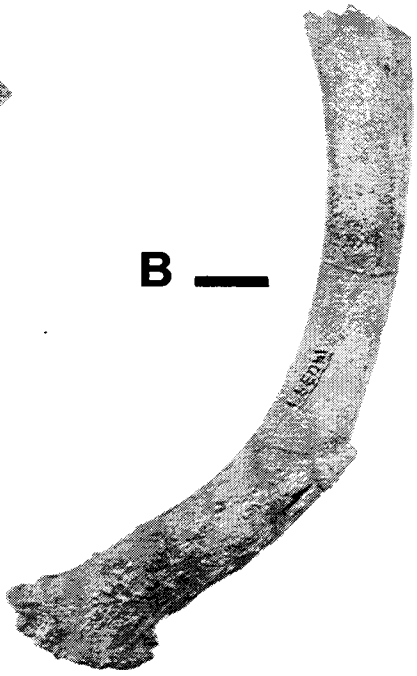

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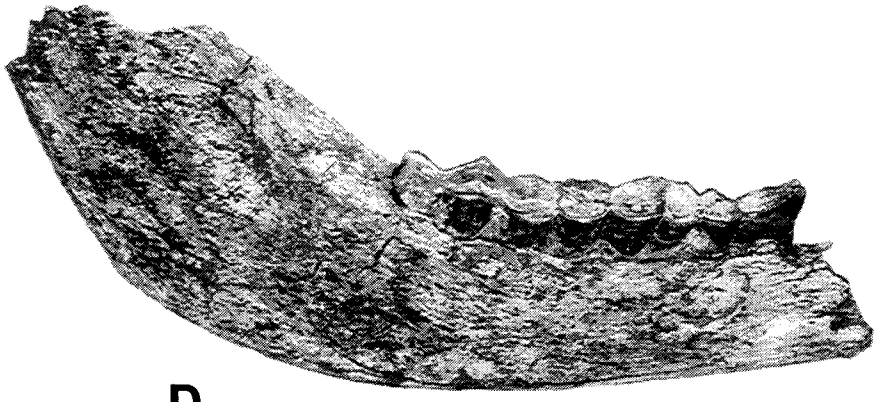

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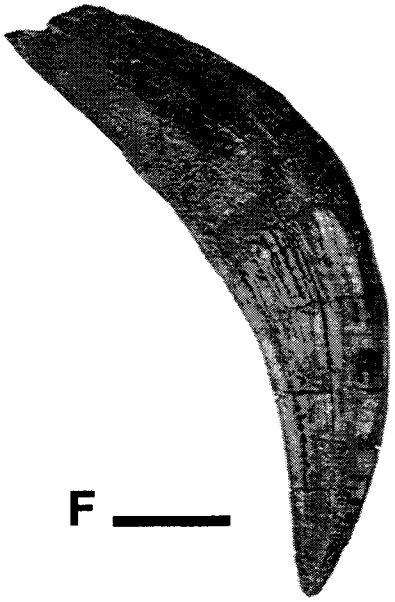

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