New Mexico Geological Society

Downloaded from: https://nmgs.nmt.edu/publications/guidebooks/35



A paleontological analysis of the Alamosa Formation (south-central Colorado--Pleistocene: Irvingtonian)

Karel L. Rogers
1984, pp. 151-155. https://doi.org/10.56577/FFC-35.151

in:

Rio Grande Rift (Northern New Mexico), Baldridge, W. S.; Dickerson, P. W.; Riecker, R. E.; Zidek, J.; [eds.], New Mexico Geological Society 35th Annual Fall Field Conference Guidebook, 379 p. https://doi.org/10.56577/FFC-35

This is one of many related papers that were included in the 1984 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

A PALEONTOLOGICAL ANALYSIS OF THE ALAMOSA FORMATION (SOUTH-CENTRAL COLORADO: PLEISTOCENE: IRVINGTONIAN)

KAREL L. ROGERS
Science Division, Adams State College, Alamosa, Colorado 81102

INTRODUCTION

The floor of the San Luis Valley of south-central Colorado is made up of Alamosa Formation sediments. The Alamosa Formation overlies Miocene Santa Fe Formation (Siebenthal, 1910). In all places where the glaciers of the Sangre de Cristo Mountains extended far enough, they deposited their moraines on top of the Alamosa Formation. The type locality of the Alamosa Formation (Siebenthal, 1910) is an outcrop called Hansen Bluff (Fig. 1), a feature created by the Hansen Bluff fault, a northern segment of the La Sauses fault where it is offset by movement of the Manassa fault. The bluff has receded somewhat eastward because of lateral erosion by the Rio Grande, which has since moved its course westward from the bluff. All wells west of the Hansen Bluff fault are artesian (C. A. Repenning, written comm. 1984).

At the type locality, fossils of fresh-water snails, vertebrate fragments, pollen, and plant remains have been reported (Lochman-Balk and Bruning, 1971). Some of the vertebrate fragments were identified as *Camelops* sp. (R. C. Peterson, oral comm.), and Price (1971) published a short list of pollen types.

Extensive fossil collection at the Hansen Bluff locality was not carried out until the summers of 1979, 1980, and 1981, when the author led crews of 12 or more to recover fossils using techniques of Hibbard (1949) and refinements of those techniques described by Waters (1978). Matrix was labeled as it was taken from the bluff, transported to the washing site in burlap bags, dried in large frames (as the matrix dried, much of the dirt dropped through the screening in the frame), transferred to a small washing box with its label, gently washed, allowed to dry, transferred to a paper bag with the label, transported to the lab, and then sorted under a dissecting microscope into small plastic boxes labeled as to location and bag number. This technique allowed for control on fossil breakage, location, and on crew-member performance. All but the smallest of fossils, such as pollen and ostracodes, were recovered in this manner.

Fossils were recovered from a 2-km-long section of Hansen Bluff (Fig. 2). Five measured sections were dug and sampled for fossils. Only one unit could be correlated with certainty along the length of the bluff. In addition, concentrations of fossils were dug from seven localities, some of which were made up of more than one unit.

The fossil assemblage has been given the name Alamosa Local Fauna after the county and town of its origin. Fossils will reside at the University of Colorado Natural History Museum, Boulder.

Recent climate of the San Luis Valley is arid to semiarid, with prevalent sunshine, cool temperatures, and frequent southwest winds. Mean annual temperature is 4 I .6°F (5.3°C), with temperatures ranging from —50°F (— 45.5°C) to 93°F (33.9°C). Mean annual precipitation is 17.35 cm. Temperatures at the valley floor are frequently cooler than those in the surrounding mountains because of temperature inversions. Cloudy days tend to moderate temperatures when they occur, although the modern cimate has only about 80 days/year classified as cloudy by the National Weather Service.

AGE OF SEDIMENTS

Sediments outcropping at Hansen Bluff are considered to be late lrvingtonian in age based upon the presence of Bishop Ash dated at 0.74 m.y. (Izett and Naeser, 1976); the Brunhes—Matuyama magnetic reversal (E. E. Larsen, unpubl.); and the presence of *Microtus paroperarius, Pitymys meadensis,* and *Equus scotti* (E. Anderson and C.

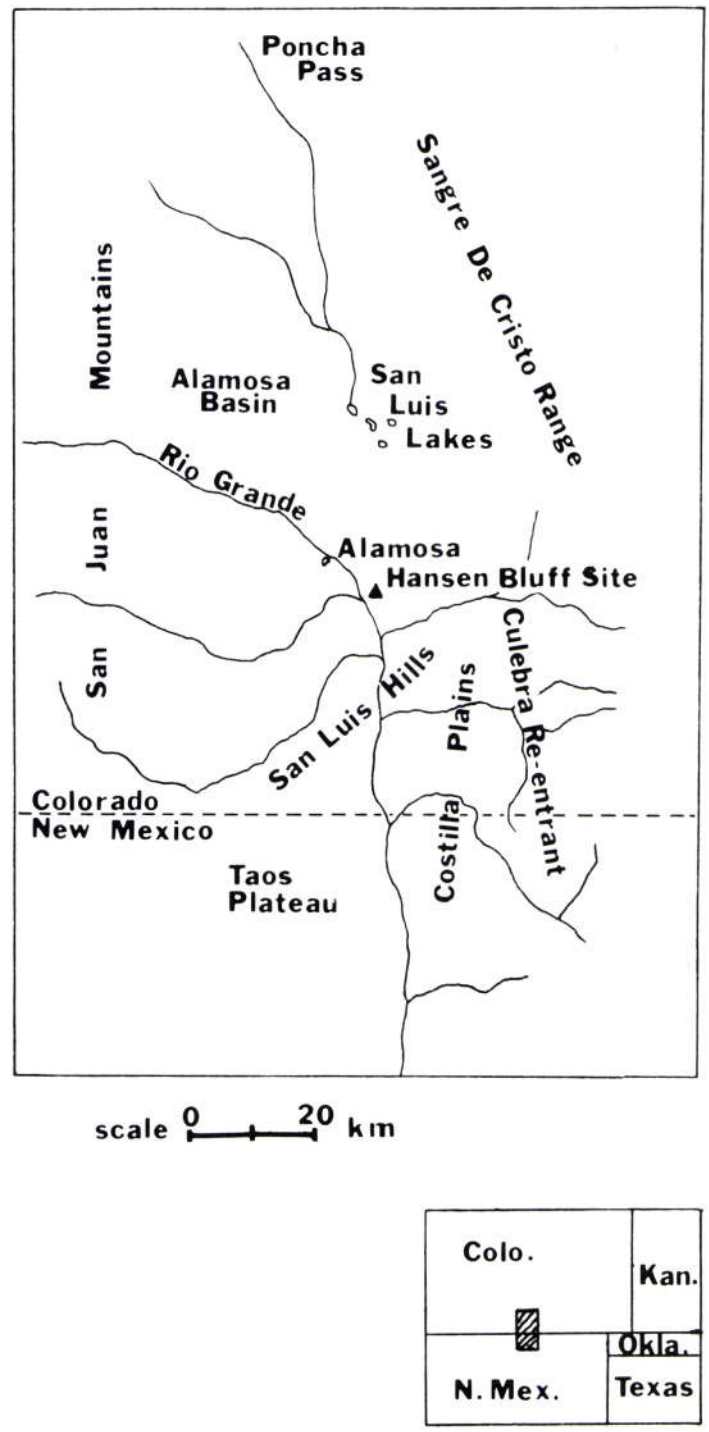


FIGURE 1. Location of the Hansen Bluff site from which the Alamosa Local Fauna has been recovered.

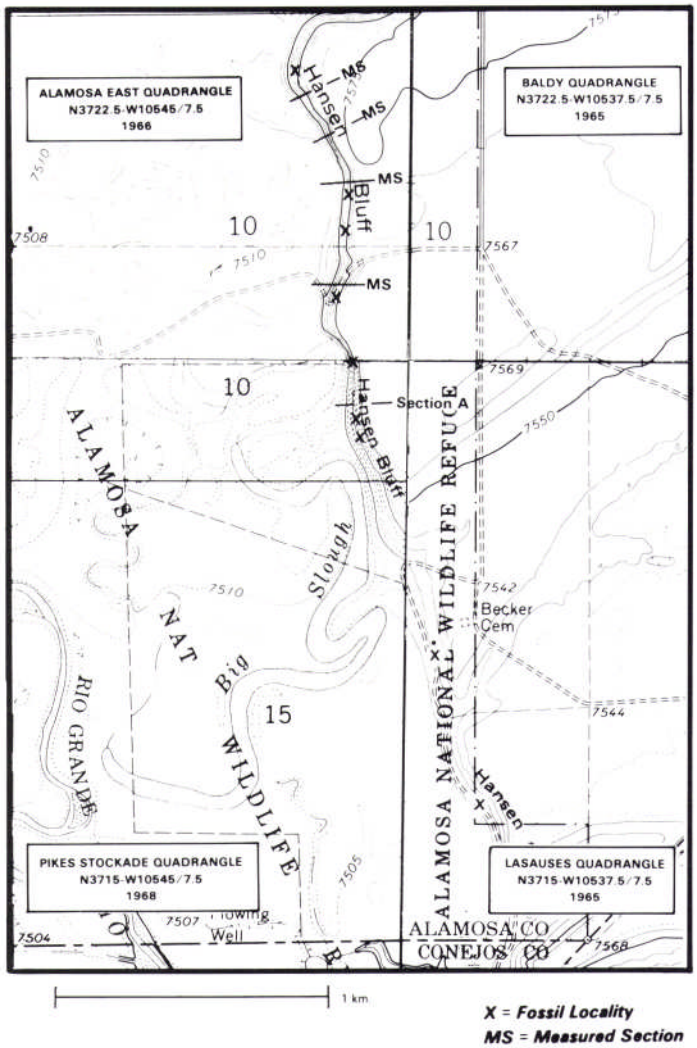


FIGURE 2. Locations of five measured sections and seven fossil-bearing localities along Hansen Bluff. The Alamosa Local Fauna has been recovered from a section of Hansen Bluff 2 km long and nearly 17 m high.

A. Repenning, unpubl.). This would correlate with the pre-Bull Lake deposits described by McCalpin (1982) in the northern part of the San Luis Valley. According to C. A. Repenning (written comm. 1984), deposits from the Sacagawea Ridge glaciation in Wyoming are cut by a terrace containing the type "0" tuff (Richmond, 1976) and are thus older than 600,000 years. This ash has not been found in the Alamosa region, but the age of sediments at the top of the section is considered to be about 0.6 m.y. based upon paleontological arguments.

Measured section A correlated with paleontological, paleomagnetic, and sedimentation data is shown in Figure 3. The Brunhes—Matuyama magnetic reversal occurs in unit 14c. All sediments above are magnetically normal and all sediments below are magnetically reversed (E. E. Larsen, unpubl.). At least two separate ashes in the sediments of the bluff have been located, but only the Bishop Ash has been identified as yet (G. A. Izett, oral comm.). Bishop Ash has not been located in section A, but its level in other sections 0.5-1.0 km away correlates with the oldest normally magnetized units above the magnetic reversal in unit 14c (Fig. 3).

A core extending 400 cm below the bottom of sediments shown in Figure 3 was sampled for paleomagnetic information, but the Jaramillo and the youngest Bandelier Tuff were not located (E. E. Larsen, written comm. 1983). Sediments at the bottom of section A are considered to be less than 0.90 m.y. old based on paleontological arguments as well as on failure to find the normal Jaramillo subchronology (C. A. Repenning, written comm. 1984).

MAJOR SIGNIFICANCE OF FOSSILS

The following information is based upon unpublished information which will appear in detailed form in a group paper (Rogers, K., Anderson, E., Brown, T., Forester, R. M., Hall, S. A., Izett, G. A., Larsen, E. E., Repenning, C. A., Smith. G. R., and Taylor, D. W., in prep.). Authors of results are given with the fossil groups.

Pollen: Information is based upon data and conclusions of S. A. Hall (unpubl.). The Alamosa Local Fauna is noteworthy in that it is the first middle Pleistocene pollen sequence in the western United States with an absolute age. Spores, pollen, and fresh-water algae are abundant up to unit 14c, indicating that the site was first a marsh, then a lake. Units up to and including unit 9 in section A have pollen assemblages representing a sage—grassland valley-floor vegetation with pine—spruce forest in the adjacent mountains. Above units 9 through I4c pollen indicate a down-elevation movement of forest vegetation, possibly associated with the onset of glaciation, but not necessarily with lowered annual temperature. Possibly temperatures were moderated, and cloud cover and moisture were increased. Units above I4c are devoid of fossil pollen.

Bryozoans: Information is based upon the identifications of E. Kaufman (oral comm.). Fossils of reworked Permian bryozoans were found at localities correlating with units 7 and 8 of section A and in unit **10** of section A. They were also found in a number of other units of the other measured sections. These fossils indicate that the source area for many of the sediments is the Whiskey Creek Formation in the Sangre de Cristo Mountains.

Ostracodes: Information is based upon the data and conclusions of R. M. Forester (unpubl.). Units 12 and 14c of section A contain concentrations of ostracodes. The lower ostracode bed is reversely magnetized and contains species that occur today in the San Luis Valley, but not together in the same bodies of water, indicating some difference in paleoclimate. Water abundance was most prominent in late winter and spring, with cold winters and warm summers. These ostracodes occur in short-lived ponds.

The upper ostracode bed in unit 14c, which is just above the Brunhes-Matuyama magnetic reversal at 0.75 m.y., contains species characteristically limited in northern distribution by winter temperature, which today occur in shallow lakes. Possibly heavy cloud cover during this time acted to moderate temperatures and reduce evaporation from water bodies. There is evidence in the ostracode fauna to indicate a trend toward warmer, drier summers from the bottom to the top of the bed.

Molluscs: Information is based upon the data and conclusions of D. W. Taylor (unpubl.). Aquatic snails with a more northern or higher than modern distribution were present in sediments correlating with unit 12 in section A. Other snails and clams in the fauna were species more characteristic of the area today, living in ponds, sloughs, or backwaters that fluctuate seasonally, or even dry up entirely. The molluscan assemblage of the Alamosa Local Fauna is most similar to that of the Cudahy Fauna in Meade County, southwestern Kansas.

Fish: Information is based upon data and conclusions of G. R. Smith (oral comm.). Four genera of fish, *Catostomus, Gila, Dionba,* and *Salmo,* are present and abundant at Hansen Bluff. *Catostomus* sp. is present as two forms; an early form present in the bottom of the section was replaced by a late form below the level of the ash in unit 14c. The two forms do not have an ancestral—descendent relationship. *Gila* sp. is present in the lower part of the section up to and including unit 14b; it is an indicator of warm water. Fossils of *Gila* sp. represent fish over 40 cm in length, much larger than modern *Gila,* which today ranges north to northern New Mexico. *Dionba* sp., today restricted to Mexico, is present at fossil localities corresponding to units 7 and 8 in section A. This species is an indicator of warm water. The uppermost units of the bluff contain remains of *Saltno,* an indicator of cold, well-oxygenated water. No living relatives of these trout are known today.

Reptiles and Amphibians: These fossils have been identified and interpreted by the author. Sixteen species of reptiles and amphibians

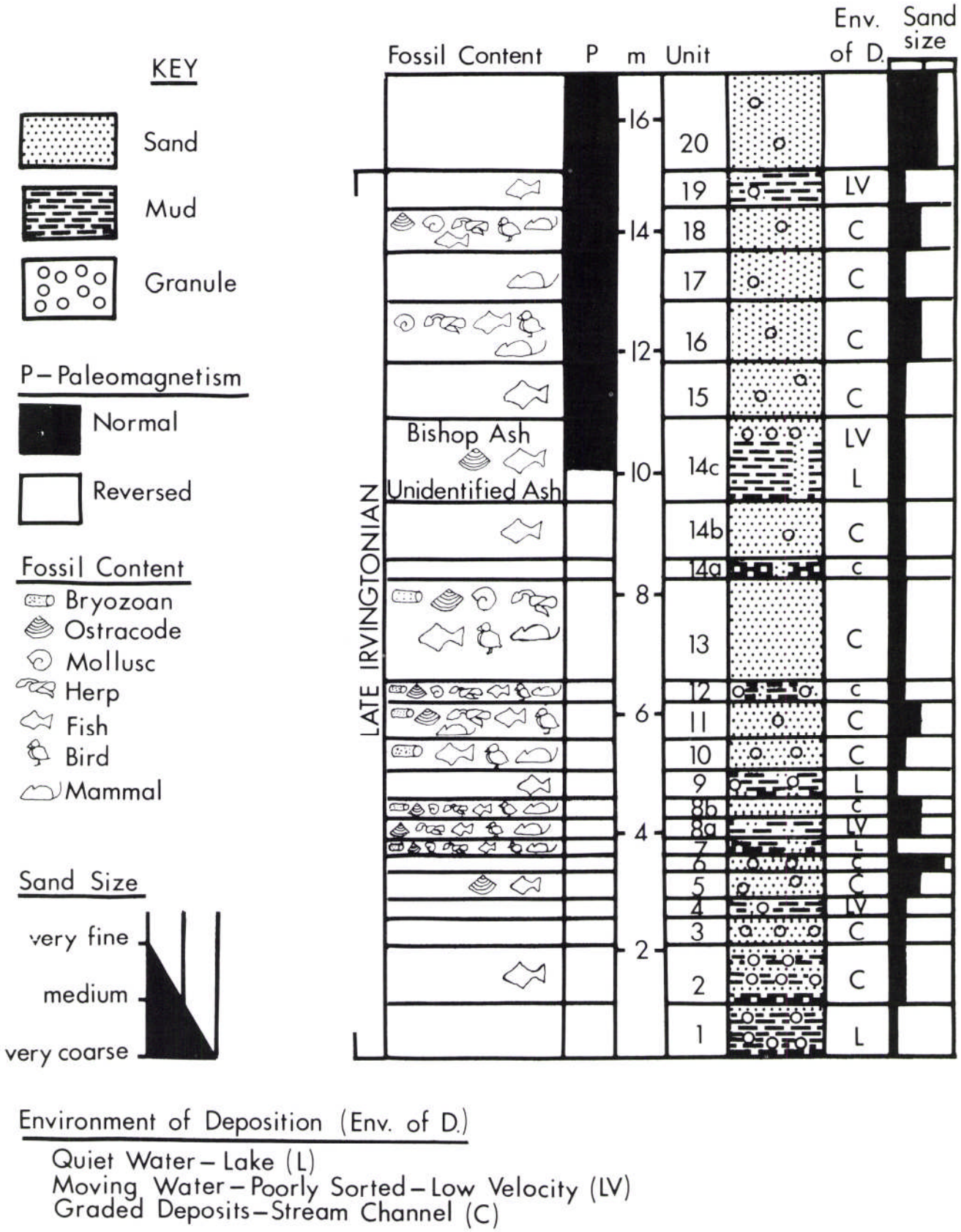


FIGURE 3. Measured section A at Hansen Bluff, Alamosa Formation, south-central Colorado. Greatest depth of the section is within Alamosa Formation.

have been identified, one of which is being described as a new species. Three of the species occur today southeast of the Sangre de Cristo Mountains, but not in the San Luis Valley. These southeastern species are present only at fossil localities corresponding to units 7 and 8 of section A.

Three faunal groupings can be recognized in the Alamosa Local Fauna: (1) the bottom of the section in units up to and including unit 9, (2) the middle of the section including units 11 through 13, and (3) the top of the section including units 15 through 19 in section A.

The oldest faunal grouping indicates relatively warm and dry times because of the presence of Front Range species that are today bounded by mean annual temperatures 5-8°F warmer than the San Luis Valley, and by the presence of neotenic tiger salamander fossils that are interpreted to indicate warm, poorly oxygenated water that did not support fish (Rogers, in press). Dry conditions are indicated by the presence of spadefoot toads.

The middle fossil grouping is consistent with what would be expected in cool, moist conditions in the San Luis Valley. Tiger salamanders were metamorphosing, as would be expected when conditions on land were more suitable for terrestrial amphibians (Rogers, in press), and the abundant *Bufo* fossils from low in the section are replaced by the more water-dependent genus *Rana.* Species with a modern range from south and east of the mountains are absent.

The upper fossil grouping seems to indicate a cold, dry climate because *Bufo* is again abundant, horned toads first appear in the deposits, very few *Rana* fossils are present, and spadefoot toads are again abundant. Salamanders from this level of the section were metamorphosing, apparently because of favorable terrestrial conditions (Rogers, in press).

Birds: Much of the information below is based upon the identifications and conclusions of J. A. Feduccia (written comm. 1980). Fossils of a duck the size of the lesser scaup and a coot, close to the living American coot, were found at localities corresponding to unit 18 in section A. Fossils similar in size and morphology to the whistling swan and to a larger than living version of the American avocet were identified from a fossil locality corresponding to units 7 and 8 in section A. Passeriform elements are abundant, but are not identifiable. All of these birds could be found in a fresh-water lake environment. In addition, one fossil of an Irvingtonian grebe is in the process of being identified to species by researchers at the University of Michigan.

Mammals: Information is based upon the data and conclusions of E. Anderson (unpubl.) and C. A. Repenning (oral comm.). Of the 22 species of mammals represented, at least nine species are extinct. There is a distinct faunal similarity to the Cudahy Fauna of Meade County, Kansas, with at least eight species present in both the faunas. The fauna consists primarily of small rodents, with very few carnivores represented. Pocket gophers of the genus *Geomys* are common throughout the section. Modern species of *Geomys* do not occur near Alamosa; the nearest modern taxon is found about 200 km northeast of Alamosa County, on the Front Range in Pueblo County. *Equus scotti* is represented by teeth and phalanges, and *Camelops* sp. is represented by metapodials. *Camelops* is known only from localities correlating with unit 18 in section A. *Microtus paroperarius* and *Pitymys meadensis* are most common in sediments corresponding to units 7 and 8 in section A, but are present throughout the entire section. *Microtus paroperarius, Pitymys meadensis, Ondatra annectens, Synaptomys meltoni, Neotoma ozarkensis,* and *Equus scotti* are indicative of Irvingtonian.

According to Repenning (written comm. 1984), the mammalian fauna does not vary greatly from top to bottom of the Alamosa Formation exposed on Hansen Bluff. One remarkable exception is apparent in the size of *Microtus paroperarius.* The first lower molars of *M. pamperanus* from the lower part of the exposures are larger than at any other published locality and average 3.5 mm in length; in the highest part of the sections these teeth average 2.9 mm in length and are comparable in size to the type material from the Cudahy Fauna of Kansas (600,000 years old). A parallel trend is known to occur in the complication of the last upper molar of most microtines. The last upper molars of *M. paroperarius* from the base of the section are more primitive than has been observed elsewhere, while those from the top of the section are complicated and comparable to the condition of this species from the Cudahy Fauna. Because of the presence of the Bishop Ash and the base of the Brunhes paleomagnetic anomaly in the section, these larger and more primitive populations of *M. paroperarius* from the lower part of the section are demonstrably older, possibly 300,000 years older, than the population in the Cudahy Fauna. It is suggested, because of the similarity of populations from the uppermost part of the Hansen Bluff sections to those of the Cudahy Fauna, that these younger faunas may approach 600,000 years in age. The cause of this progressive decrease in size of *M. paroperarius is* not known, although populations (presumably of an even younger age) with even smaller first lower molars than those in the Cudahy Fauna are known. The species becomes extinct at the end of the Irvingtonian mammalian age, about 450,000 years ago, and is replaced by immigrant *M. pennsylvanicus,* which is still extant. No post-lrvingtonian index species are recognized with the exception of species of *Microtus* that are believed to have been inadvertently included in samples due to slope wash of modern material.

Sedimentation: Information is based upon the data and conclusions of T. Brown (written comm. 1983). Sedimentary analysis was done by dry sieve and settling tube, and resulted in definition of three major environments of deposition: quiet water, such as a lake or pond; fluvial, low-velocity currents; and fluvial stream-channel deposits. Sediments of section A are primarily channel deposits with thin layers of low-energy sediments in units 19, 14c, 8, and 4, and lake deposits in units 14c, 9, 7, and I (Fig. 3).

CONCLUSIONS

The following conclusions are those of the author and do not necessarily correspond with those of other workers, although the author's conclusions have been modified extensively due to comments by C. A. Repenning (written comm. 1984).

Sediments cropping out at Hansen Bluff probably represent a span of time from about 0.6 to nearly 0.90 my. and include two interglacials and one glacial period. The glacial period was probably not colder, on the average, than is the modern climate as judged by the composition of the fauna. Increased cloud cover during that time may have resulted in moderated temperature extremes as well as greater humidity, as indicated by the pollen, ostracodes, reptiles, and amphibians. The glacial period, however, was probably colder, as well as wetter, than the preceding interglacial, judging by the loss of poikilotherms that occur today only on the Front Range where modern temperatures are warmer than in the San Luis Valley. The last interglacial is indicated by a drying trend, probably brought on by decreased cloud cover, but without much evidence of warming climate except for evidence of the ostracodes that suggest warmer, dryer summers in the higher parts of unit 14c and increasing seasonality. During the glaciation, species of molluscs occurring today at higher elevations or with a more northern modern distribution are represented in the fauna.

Overall, the entire fauna is very r-selected compared to low-altitude faunas, resulting in low diversity, high abundance of individual species, and in species being represented primarily by small, immature individuals. This is characteristic of unstable environments with frequent harsh conditions and periodic die-offs. Possible evidence of thermal stress is shown in some species by increased or decreased body size in homeotherins or poikilotherms, respectively. During the glacial period the fauna shows some increase in r-selection, with decreased faunal diversity in coldblooded forms.

Boellstorff (1978) indicates that the type Nebraskan till at Afton, Iowa, is reversely magnetized and older than the 0.7-my-old Hartford Ash, but younger than the 1.2-m.y.-old Coleridge Ash. He also indicates that the type Aftonian paleosol contains both the Hartford Ash and the restricted Pearlette Ash (type "O" of 0.6 m.y. and, in Kansas, containing in its base the Cudahy Fauna). The presence of the 0.74-my.-old Bishop Ash in several of the sections at Hansen Bluff, and of the change from Brunhes normal polarity to Matuyama reversed polarity slightly down section from the position of this ash, clearly suggests that the central part of the type Alamosa Formation is correlative with the type Nebraskan till. This part of the section, including units 10

through the lower part of 14c shows evidence of cooler, moister summers (frogs, salamanders, and possibly molluscs) and milder, but wetter, winters. The overlying units of the type Alamosa Formation, probably beginning in the younger half of unit 14c, seem to be a correlative of the type Aftonian paleosol, even though the type "0" Pearlette Ash has not been found in the San Luis Valley, since *Microtus paroperarius is* reduced in size to that known from the Cudahy Fauna. The underlying "interglacial," unit 9 and older, has not been named in North America. Uplift of Hansen Bluff along the Hansen Bluff fault would appear to have taken place during the Aftonian and possibly just before 600,000 years ago. No later deposition took place on the bluff with the exception of wind-blown silt and a conspicuous caliche zone.

ACKNOWLEDGMENTS

This research was funded by the National Geographic Society grants 2115-79, 2165-80, and 2328-81, and I thank the Society for its generosity. I am most grateful to E. Anderson, T. Brown, J. A. Feduccia, R. M. Forester, S. A. Hall, G. A. Izett, E. E. Larsen, C. A. Repenning, G. R. Smith, and D. W. Taylor for agreeing to work with me on this project, identifying and interpreting fossils. Thanks are also due to the many students who spent long hours hauling, washing, and picking. Personnel of the Alamos and Monte Vista Wildlife Refuges were very helpful, especially Mel Nail. The illustrations were prepared by John Leak and Lynn Slocum.

REFERENCES

Boellstorff, J., 1978, North American Pleistocene stages reconsidered in light of probable Pliocene—Pleistocene continental glaciation: Science, v. 202, pp. 305-307.

Hibbard, C. W., 1949, Techniques of collecting microvertebrate fossils: University of Michigan, Contributions from the Museum of Paleontology, v. 8, no. 2, pp. 7-19.

Izett, G. A., and Naeser, C. W., 1976, Age of the Bishop Tuff of eastem California as determined by the fission-track method: Geology, v. 4, pp. 587-590.

Lochman-Balk, C., and Bruning, J. E., 1971, Lexicon of stratigraphic names used in south-central Colorado and northern New Mexico, San Luis Basin; *in* James, H. L. (ed.), Guidebook of the San Luis Basin. Colorado: New Mexico Geological Society, Guidebook 22, pp. 101 111.

McCalpin, J., 1982, Quaternary geology and neotectonics of the west flank of the northern Sangre de Cristo Mountains, south-central Colorado: Colorado School of Mines Quarterly, v. *77* no. 3, pp. 1-89.

Price, C. R., 1971, Preliminary paleopalynological analysis of Alamosa Formation sediments; *in* James, H. L. (ed.), Guidebook of the San Luis Basin, Colorado: New Mexico Geological Society, Guidebook 22, pp. 219-220.

Richmond, G. M., 1976, Pleistocene stratigraphy and chronology in the mountains of western Wyoming; *in* Mahaney, W. C. (ed.), Quaternary stratigraphy of North America: Dowden, Hutchinson, and Ross, Stroudsburg, Pennsylvania, pp. 353-379.

Rogers, K. L., 1984, Facultative metamorphosis in a series of high altitude fossil populations of *Ambystoma tigrinum* (Irvingtonian: Alamosa County, Colorado): Copeia, in press.

Siebenthal, C. E., 1910, Geology and water resources of the San Luis Valley, Colorado: U.S. Geological Survey, Water-supply Paper 210, 128 pp.

Waters, B., 1978, Modified bulk sampling of fossils: Curator, v. 21, no. 2, pp. 136-148.



San Luis Valley Southern's No. 105 heads south over the Rattlesnake Canyon trestle with a string of empty "refers" for vegetable shipments. This engine was torn down and abandoned in the early 1950's (photo by Bob Richardson).



The Rattlesnake Canyon trestle is in fairly good condition after 74 years, but is no longer in use.