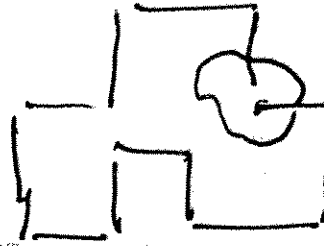


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*NSF study
literature search*

*1-4 wks w/ 4 ppl.
locality - findings
BLM - Class 5 ; full strat recommendations
work*

**PRELIMINARY PALEONTOLOGICAL ASSESSMENT
CASE PROPERTY, CORRAL BLUFFS,
EL PASO COUNTY, COLORADO**

Dr. Paul C. Murphey
Paleontology Principal Investigator
April 29th, 2008

Summary

Fossils observed within the Case Property during the site reconnaissance for this assessment include abundant fossil wood fragments, well preserved logs up to approximately 15 feet in length, locally abundant and well preserved leaves, twigs, and roots; and moderately well preserved burrows and root casts. Plant fossils appear to be common and well preserved throughout the exposed section, and nine new fossil localities were recorded. No vertebrate fossils were observed. However, given the limited time available, this is not surprising. Early Paleocene (Puercan) mammal fossils are typically small in size, and are often only discovered by screenwashing of bulk matrix samples. The existence of 33 previously recorded museum fossil localities in the Corral Bluffs area in close proximity to (and some potentially within) what is now the Case Property indicates the virtual certainty that additional vertebrate fossils are present in the area.

The following factors combine to demonstrate the high paleontological sensitivity of the Case Property: 1) the density of fossil occurrences in the Corral Bluffs area is high, and it has yielded well preserved fossils of plants and early Paleocene (Puercan) reptiles and mammals; 2) the Corral Bluffs area is particularly noteworthy from a scientific perspective because it contains a well-exposed and relatively thick sequence of the Denver Formation, including the rarely exposed K-T boundary; and 3) the Corral Bluffs Denver Formation sequence which is so well-exposed within the Case Property is extremely relevant to ongoing NSF-funded scientific research being conducted by scientists and students at the DMNS and UCM whose work documents late Cretaceous and early Tertiary paleoenvironments and biotas of the Denver Basin. It is important to point out that although the Corral Bluffs area

is known to be of scientific importance as the result of the limited amount of work that has taken place there previously, the area has been largely inaccessible to paleontologists for the last several decades. Therefore, the area has not been adequately studied in the broader context of current K-T boundary research and questions regarding earliest Tertiary faunal and floral radiation and diversification following the K-T boundary extinction event.

Without mitigation, ground disturbance associated with development within the Case Property will undoubtedly result in the destruction of scientifically significant fossils. However, given the limited amount of data generated during the field reconnaissance for this preliminary assessment, it is not yet possible to develop meaningful development-specific mitigation options. Prior to development within the Case Property, it is strongly recommended that a full stratigraphically-controlled paleontological survey be completed in order to generate the information required to fully evaluate development alternatives and study mitigation options. Any future paleontological surveys and all project-specific mitigation measures should be designed in such a way as to lessen adverse impacts on non-renewable paleontological resources to below the level of significance while supporting the ongoing related research of scientists from the DMNS and UCM. Because of the abundance, diversity and scientific importance of fossils in the Corral Bluffs area, together with the fact that it is the largest exposed sequence of late Cretaceous and early Tertiary rocks in the Denver Basin, mitigation strategies should include avoidance of highly fossiliferous areas, monitoring of construction excavations, and salvage of scientifically significant fossils. Importantly, if development of the Case Property proceeds, the mitigation of adverse impacts on paleontological resources should be regarded as an opportunity for community involvement with possibilities for on-site interpretive exhibits and education.

Statement of Objectivity

As a consultant, I have completed hundreds of paleontological resource management studies located in ten western states for numerous private and public sector clients since 1995. I do have previous experience working as a consulting paleontologist in the Denver Formation, mostly for highway-related survey and mitigation monitoring projects in the Denver area. I recognize the scientific significance of the Denver Formation and its contained fossils, and respect the importance of the ongoing research by curators from the Denver Museum of Nature and Science (DMNS) and the University of Colorado Museum of Natural History (UCM). However, I have no personal research involvement or other interests concerning the geology or paleontology of the Denver Formation that would bias the conclusions made in this report.

Methods

The Case Property consists of 522 acres located within sections 5 and 6, T. 14 S., R. 64 W. On Saturday, April 26, 2008, Nancy Prieve of the El Paso County Environmental Services Department accompanied four SWCA paleontologists on a reconnaissance inspection of the Case Property. The inspection lasted for approximately 5 hours (including the hike to and from the property) and took place between 9:30 A.M. and 2:30 P.M. Access to the property was from the northwest corner of the Waste Management Facility (center, Section 5, T. 14 S., R. 64 W.) into the northern half of the southeast quadrant of the Case Property. Due to

the limited available field time, the areas within the Case Property that were inspected were focused within the NW¹/₄ SW¹/₄ Section 5, and the SE¹/₄ NE¹/₄ Section 6, T. 14 S., R. 64 W. Thus, the inspection was restricted to the east-central portion of the property, and proceeded in a clockwise fashion as an approximate line from points A to J (see Figure 2). No fossils were collected, and stratigraphic positioning of fossil localities that were discovered was not attempted because it was not feasible with the limited time. Geographic data were recorded using a Trimble GPS loaded with ArcPad software and a customized paleontological data dictionary.

It should be noted that depending upon the nature of a fossil discovery and the research questions being asked, work at an individual fossil locality can take hours to months to complete. However, during a typical paleontological inventory, if there is no fossil collection involved, the amount of time needed to document a fossil locality is considerably less, typically less than an hour. For this project, the goal was to locate and document as many significant fossil occurrences as possible in the available timeframe in order to assess the abundance of fossils on the property.

Fossils observed within the Case Property consist either of *ex-situ* fossils that have eroded onto the surface and have mostly moved downslope from their place of origin, *in-situ* fossils that are partially or completely exposed, or *in-situ* fossils that were discovered by quarrying of areas where weathered and fragmentary remains have eroded onto the surface. Data collected include geographic coordinates, elevation, fossil types and extent of deposit, and lithology types. A combined fossil locality map and individual fossil locality summary forms are provided (see Figure 2 and Appendix A).

Resource Assessment Criteria

In recognition of the fact that occurrences of paleontological resources are closely related to the geologic units in which they are contained, the potential for occurrences of scientifically important fossils can be broadly predicted by the presence of the pertinent geologic units at or near the surface. As a result, geologic mapping can be used to predict the likelihood of occurrences of important paleontological resources at specific locations. The Potential Fossil Yield Classification System (PFYC) is increasingly utilized as a resource management tool by government agencies and private paleontologists working throughout the western United States. It was recently revised and adopted by policy as the BLM (BLM IM 2008-009), and the most recent version is appended to this report (Appendix C). The PFYC system ranks geologic units according to their paleontological sensitivities as determined from published scientific literature and unpublished museum data. For this study, the paleontological sensitivity of the Denver Formation in the Corral Bluffs area was evaluated using the PFYC.

Overview of the Denver Formation

Of synorogenic origin, the Denver Formation consists of dark brown, yellowish-brown, and grayish-olive tuffaceous claystone, mudstone, and sandstone beds interbedded with scattered conglomerate (Bryant et al., 1981; Soister, 1978; Trimble and Machette, 1979). Throughout its distribution, it is unconformably underlain by the Laramie or Arapahoe

formations, and is unconformably overlain by surficial sedimentary deposits of Pleistocene and Holocene age to the east of the Front Range in the Denver Basin.

The Denver Formation is largely composed of altered andesitic (volcanic) debris, and was deposited during the Laramide uplift of the Rocky Mountains in rivers and on alluvial floodplains in a tropical forest environment. Spanning from the latest Cretaceous (Lancian) to the Paleocene (Puercan), "D1" deposits of the Denver Formation preserve the Cretaceous-Tertiary (K-T) boundary (the well known dinosaur mass extinction event), which is reflected by the presence of dinosaur fossils below the boundary and early Paleocene mammal fossils above the boundary. "D1" Denver Formation strata are unconformably overlain by "D2" strata, which are early Eocene in age based on scant fossil evidence. The boundary between "D1" and "D2" strata consists of a widely distributed paleosol deposit (Johnson and Reynolds, 1999; Reynolds and Johnson, 2003).

The Denver Formation preserves locally abundant and scientifically significant plant fossils (Brown, 1943; 1962; Ellis et al., 2003; Johnson and Ellis, 2002; Knowlton, 1930), and a less abundant but scientifically important fossil vertebrate fauna (Dewar, 2003; Eberle, 2003; Middleton, 1983; Middleton and Dewar, 2004). The fossil flora is highly diverse, and has been documented from approximately 150 stratigraphically controlled localities, including the well-publicized Castle Rock Rainforest Site along I-25 south of Denver (Johnson et al., 2003). Vertebrate fossils of the Denver Formation include a diversity of Cretaceous-age dinosaurs and early Paleocene-age mammals (Carpenter and Young, 2002; Eberle, 2003). Non-dinosaurian reptiles such as crocodylians and turtles are known from both Cretaceous and Paleocene strata. Both the DMNS and UCM have numerous recorded Denver Formation localities from around the Denver Basin.

The geology and paleontology of the Denver Formation remains the subject of active research by scientists and students at the DMNS and UCM. This work has added considerably to our understanding of the geologic and biotic history of the Denver Basin and surrounding areas during the late Cretaceous and early Tertiary (Carpenter and Young, 2002; Eberle, 2003; Ellis et al., 2003; Johnson and Ellis, 2002; Johnson and Reynolds, 1999). Because it is largely covered throughout much of its distribution, construction-related excavations which expose Denver Formation strata represent an important data source. As a result, it has become standard practice for CDOT to require paleontological assessments for ground disturbing projects that impact rocks of the Denver Formation, and an increasing number of city and county agencies are following suit.

Because the Denver Formation contains scientifically significant, locally abundant and well preserved plant fossils and less common but locally well preserved and scientifically important vertebrate fossils, it is considered to have high paleontological sensitivity, and merits designation as PFYC Class 5 throughout its distribution (see Appendix C).

Literature and Museum Record Searches

The Denver Formation in the Corral Bluffs area is important because it preserves not only the Cretaceous-Tertiary boundary, but it is highly fossiliferous. In addition to abundant and well preserved fossil plants, it preserves fossils of primitive mammals that represent a

portion of the earliest Paleocene Puercan North American Land Mammal age. Fossils representative of this critically important time in the evolution of mammals are rare, in large part because few sedimentary sequences of this age exist in North America. The Puercan records the rapid diversification and increase in body size of mammals over the first million years after the extinction of the dinosaurs (Eberle, 2003).

The mammalian fossil assemblage of the Denver Formation in the Corral Bluffs was first described by University of Colorado student Middleton as part of his doctoral research (Middleton, 1983). It was more recently studied by Eberle (2003), who revised the taxonomy and biostratigraphy, assigning the assemblage as a probable correlate with Puercan biochronologic interval Pu2. Known mammalian fossil taxa from Corral Bluffs are listed in Table 1, but fossil reptiles including turtles and crocodylians have also been collected.

It is important to point out that since the work of then CU graduate student Mike Middleton in the 1970's and early 1980's, most of the Corral Bluffs area (including what is now the Case Property) has been inaccessible to paleontologists. The Denver Formation underlies most of Corral Bluffs where it is relatively well-exposed (figures 1-3). Work to the west in the Jimmy Camp Creek area has made it possible for Dr. Kirk Johnson of the DMNS to extrapolate the approximate position of the K-T boundary at Corral Bluffs, but the precise position of this important boundary has not been confirmed, and to my knowledge, no detailed stratigraphic work at Corral Bluffs has thus far been completed. In summary, although previous work in the area has demonstrated the scientific importance of Corral Bluffs, the level of rigorous scientific investigation that has been applied to the Denver Formation elsewhere within the Denver Basin has not yet been applied to the important highly fossiliferous Corral Bluffs sedimentary sequence.

Table 1. Fossil mammals known from early Paleocene (Puercan biochron Pu2) strata of the Denver Formation at Corral Bluffs (compiled from Eberle, 2003).

Order MULTITUBERCULATA

Neoplagiaulacidae, genus and species indet.

Order CONDYLARTHRA

Oxyclaenus cf. *O. cuspidatus*

Loxolophus hyattianus

Loxolophus aff. *L. hyattianus*

Loxolophus faulkneri

Desmatoclaenus cf. *D. protogonioides*

Mioclaenidae genus and species indet.

Ectoconus ditrigonus

Periptychus coarctatus

Conacodon entoconus

Conacodon aff. *C. entoconus*

Conacodon delphae

Table 2. DMNS and UCM Denver Formation fossil localities within the Corral Bluffs 7.5' Topographic Quadrangle, El Paso County, Colorado.

Locality Number	Locality Name	Institution	Township	Range	Formation
417	Corral Bluffs 1	DMNS	13S	64W	Denver Fm
418	Corral Bluffs 2	DMNS	13S	64W	Denver Fm
2538	Corral Croc Jaw	DMNS	14S	65W	Dawson Arkose
2540	Corral Log 201	DMNS	14S	65W	Dawson Arkose
2541	Corral Log 211	DMNS	14S	65W	Dawson Arkose
2545	Turd Locality	DMNS	14S	64W	Denver Fm
2546	Energizer Turtle	DMNS	14S	65W	Denver Fm
2547	The Claw	DMNS	14S	65W	Denver Fm
2548	Alligator Rock	DMNS	14S	65W	Denver Fm
2549	Sandy Webb's Site	DMNS	14S	65W	Denver Fm
2550	Turtle Butte	DMNS	14S	65W	Denver Fm
2552	Charlie's Haircut	DMNS	13S	65W	Denver Fm
2553	White Turtle Locality	DMNS	14S	65W	Denver Fm
2554	Mad Cow	DMNS	14S	65W	Denver Fm
2555	Pieces of Perip	DMNS	14S	65W	Denver Fm
3246	Turtle Bones	DMNS	14S	64W	Dawson/Denver
77274	Delph's Locality	UCM	14S	65W	Dawson/Denver
77275/2544	M-77A, Carner Site	UCM/DMNS	13S	64W	Dawson/Denver
77276	A-Locality	UCM	14S	65W	Dawson/Denver
77277	M-77C	UCM	13S	64W	Dawson/Denver
77278/2551	The Dead Tree Lives	UCM/DMNS	14S	65W	Dawson/Denver
77279	M-77E	UCM	14S	65W	Dawson/Denver
77280	M-77G	UCM	14S	64W	Dawson/Denver
77281	M-77H	UCM	14S	64W	Dawson/Denver
77287	M-77I	UCM	14S	64W	Dawson/Denver
77288	M77-J	UCM	14S	64W	Dawson/Denver
79012	Corral Bluffs Buttress	UCM	14S	64E	Dawson/Denver
82126	Corral Bluffs General	UCM	13S	64W	Denver Fm
83069	Adocus Locality	UCM	14S	64W	Denver Fm
83095	M-78K	UCM	14S	65W	Denver Fm
83097	Carl's Cranium	UCM	14S	65W	Denver Fm
83098	CB-14	UCM	14S	64W	Denver Fm
83196	M-77F	UCM	14S	65W	Denver Fm

Thirty three previously recorded museum fossil localities occur in the Denver Formation within the Corral Bluffs 7.5' Topographic Quadrangle (Table 2). Although specific locational information for these localities is not provided in this report, the coordinates recorded for at least two of the UCM localities (Locs. 77287, 77288) indicates that they lie within what is now the southwest quadrant of the Case Property. All of the DMNS localities are located to just to the west of the Case Property at the same approximate stratigraphic interval that is exposed within the Case Property. The large number of museum fossil localities at Corral

Bluffs attests not only to the high fossil content of the Denver Formation in the area, but it indicates a high likelihood that additional undiscovered fossils occur within the Case Property.

DRAFT

