On December 14, 2004, the California Independent Systems Operator (ISO) officially opened a new electrical power line between the San Joaquin Valley towns of Los Baños and Coalinga. The construction of this power line will ease transmission problems between Northern and Southern California. The following "web report" below is based on the paleontological discoveries resulting from the power line construction – much was learned from the project, and even several new species of animals were identified! For more information about the Path 15 project, you can go to the following web links:
http://www.wapa.gov/sn/initiatives/path15/
http://www.maslonka.com/path15.asp

Highlights and Excerpts from:

Final Report on the Bonebeds Excavated at 45/1 and 46/2 Structures on Path 15

(December 2004).

Edited, photos by E. Zaborsky, BLM Hollister Field Office (12/20/2004).

EDITOR'S NOTE: Only the resources from 45/1 are discussed, as this site is located on BLM Public Lands.

Acknowledgements:

Dr. J.D. Stewart was the lead paleontologist for the project. He supervised the initial site investigation, excavation, specimen preparation, and was the preparer of the original report (cited above).

Marjorie Hakel, Nancy Harris, and Edward Gojmerac conducted the primary site excavations and all specimen preparation for the bone beds at 45/1.

Background:

Two bonebeds at site 45/1 were identified and excavated as part of National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) compliance for the construction of a power line ("Path 15") between Los Baños and the Coalinga area. More than 1,200 vertebrate fossils were collected.

The fossils recovered at 45/1 were primarily terrestrial mammals and freshwater snails that date to the late part of the Middle Miocene Period, approximately 15-16 million years ago [mya].

Prior to the discovery of the bonebed at 45/1, the only site producing terrestrial vertebrate fossils from the Temblor Formation was discovered near Coalinga sometime before 1915. Notable aspects of the 45/1 bonebed include the first amphibians, tortoises, birds, rabbits, terrestrial snails, and freshwater snails ever found in the Temblor Formation. Also, a new genus and species of a badger/wolverine-like mustelid was recovered.

Surveys, Monitoring, and Mitigation:

A survey for paleontologic resources along the 82-mile route of Path 15 was conducted in 2003. The resulting report (Padon and Stewart 2003) ranked segments of the route as of low, moderate, and high paleontological sensitivity. Their report identified 18 miles of moderate sensitivity and approximately 29 miles of high sensitivity, and recommended certain measures to mitigate the adverse impact of construction activities upon these resources. The 45/1 quarry lies within a segment determined to be of high sensitivity.

The contract for constructing Path 15 was awarded to Maslonka and Associates. That firm contracted the services of Jones & Stokes, Inc., to act as a third party to monitor construction activities and mitigate impacts for biological, cultural, and paleontological resources. The BLM issued a Scientific Paleontological Collecting Permit to Bruce Hanson (Jones & Stokes). Jones & Stokes personnel wrote paleontological monitoring guidelines that were approved by Western (Western Area Power Administration, Department of Energy) and the BLM.

Monitoring of pad construction activities revealed the bonebeds at 45/1. A special contract was issued for the recovery of paleontological resources at 45/1 because the fossil deposits detected at this site were disproportionately rich compared to all the other sites investigated during Path 15 line construction.

Geographic Setting:

The 45/1 site lies on the east face of the Ciervo Hills in a region known as Monocline Ridge. The elevation of the pad is 960 feet (293 meters) ASL (Above Sea Level). It lies on the north side of an unnamed arroyo flowing southeast out of the hills between Tumey Gulch and Arroyo Hondo (*Figure 1*).

Figure 1: Site Location Overview

Geologic Setting:

Surficial sediments in the area of 45/1 range in age from Middle Miocene to Holocene (approximately 17 mya to the present). The Temblor Formation is a sequence of marine sandstones, sands, and shales of Middle Miocene age. The sandstones are resistant to erosion. This fact, combined with extensive uplift along the axis of the Diablo Range, has created steep hogbacks from the resistant ledges along the range. Probably the best-known horizon in the formation is the so-called "button beds." The name derives from the abundance of small button-size echinoids (sand dollars). In some places, marine mammal fossils, especially those of desmostylians, can be excavated.

At one time, the sandstones forming the Temblor Formation were assigned to the Vaqueros Formation by Arnold & Anderson (1910), who regarded the Temblor as a synonym for the Vaqueros. The Vaqueros Formation is now known to be older than the Temblor formation, and they contain different faunas (Woodring et. al. 1940).

Dibblee (1975) dropped the use of Jacalitos and Etchegoin formations to describe terrestrial sediments above the Temblor Formation, labeling these sediments only as "unnamed nonmarine sediments." None of the sediments overlying the Temblor in the Tumey Hills Quadrangle mapped by Dibblee (1975) are marine. In some areas, such as the Kettleman Hills (to the south of the area of our concern), several marine formations overlie the Temblor Formation.

In 1915, Merriam described a group of terrestrial animal fossils quarried by UC Berkeley staff from Temblor Formation sediments along Domengine Creek. He named this part of the Temblor Formation the *Merychippus* zone. It was considered of great importance because it provided an opportunity to tie the terrestrial biological sequence into the West Coast marine biological sequence. The students of Chester Stock at Caltech made another collection of vertebrate fossils from the *Merychippus* zone that were later studied by Bode (1933, 1934, 1935), who named this group of mammals the North Coalinga local fauna.

Geology of the 45/1 Site:

The pad for tower 45/1 was constructed by leveling a small hill. The area is prone to landslides, and numerous hills and slumps in the area are composed of landslide debris (Dibblee 1975). The small hill that is now the pad for 45/1 was not mapped as landslide debris, but the geology exposed by pad holes adjacent to the bonebed indicates so. Continuing rains through January exposed more bones in the fill, and 10 gallons of fossiliferous sediment dislodged by the bulldozer were screened to check for fossil microfauna. Snails were the only fossils noted in the fine fractions. Setting of forms and hanging of rebar took place in late January. Pouring of concrete occurred in early February.

The pertinent staff of Western and Maslonka were notified of the discovery, as was Erik Zaborsky (BLM Hollister Field Office archaeologist). Mary Barger (Western archaeologist) and John Bridges (Western biologist) visited the site on January 21, 2004, to verify the findings. David Lawler (BLM California State paleontologist) visited the site on February 13. Subsequent discussions with BLM, Western, and Jones & Stokes personnel produced a plan to excavate the top 6” (15.2 cm) of the bonebed and then cover the bonebed to protect the resource from the elements. Approval was given to excavate the bonebed, prepare the fossils, and report the findings. It was agreed that the University of California Museum of Paleontology at Berkeley (UCMP) would be the repository for the collection. Excavation was initiated on April 12. There was a hiatus from June 11-28; excavation was resumed on June 29 and continued until July 12, 2004.

Excavation Personnel:

Most of the excavation of specimens at the 45/1 site was done by Jones & Stokes employees J. D. Stewart, Marjorie Hakel, Nancy Harris, Edward Gojmarac, and Richard Serrano. Volunteers provided by the BLM included Philomene C. Smith, Philomene R. Smith, Nichelle Serrano, Lisa Orr, Stacy and Gerry Goss, and Ray Iddings (*Figure 2*). BLM employees Erik Zaborsky, Lesly Smith, Kim Perry, Gary Diridoni, and Steven Horne all helped to excavate. Vikkie Jacklich, a public relations specialist and avocational paleontologist, assisted with the project. Elizabeth Rampe, a geology student at Colgate College, contributed her expertise to the excavation. Western employees Mary Barger and Joe Giliberti also excavated fossils at 45/1.

Figure 2: BLM Employees and Volunteers Assist the Paleontology Specialists at the 45/1 Site.

Recovery Methods:

The entire length of the bonebed was divided into one (1) meter segments (approximately 3.3'), numbered from west to east. Because initial testing of the bonebed indicated that it was more than a meter wide in some places, each meter segment of length was divided into a northeast square meter 'A' and a southwest square meter 'B'.

Probing of fill at the east end of the pad revealed the original east edge of the hill, as indicated by buried rooted vegetation. Systematic excavation of the bonebed began at that end and proceeded westward. The original plan was fashioned in the manner of excavations typical of fairly flat-lying strata. The 6" (15.2 cm) depth would be excavated in three 2" (5.1 cm) deep intervals. Many of the larger bones penetrated all three artificial intervals because of the dip of the strata, and that approach soon was found to be infeasible. The more natural approach was to work through bedding planes, and thus excavation of a square meter was executed from north to south or vice-versa. Positions of identifiable fossils were mapped, one meter square per page. Orientations of long bones and flat bones were determined with a Brunton compass and recorded. Well-defined stratigraphic contacts, presence or absence of clay pebbles, and presence of caliche and opal were also recorded.

Digital photographs were taken of important features and of excavated and swept quarry floors. Each identifiable fossil was assigned a number and placed in an appropriate container (plastic film canister, ziplock bag, etc.) with that number (*Figure 3*). Cyanoacrilate was the primary preservative used during the excavation. White glue was employed for hardening of some large and porous blocks of sediment. When dense accumulations of bones were encountered, they were removed in plaster jackets and later dismantled elsewhere in order to minimize the time spent on the pad. A gasoline-powered electric generator was employed to power a diamond saw and an air compressor and pneumatic jackhammer when necessary. The sediments excavated from each square were saved in plastic containers. Each container bore the number of the square, and these were set aside for future screening and picking.

Figure 3: Recovered Fossil Specimens

When the excavation reached the 14-15 meter interval, the existence of a second bonebed lying parallel to and northeast of the original was discovered. It became clear that the number of fossils being recovered and the hardness of much of the matrix prohibited the excavation of both bonebeds to their western termini within the constraints of the construction schedule, even with considerable volunteer help. It was therefore decided to spend the remainder of the time focusing on the upper (northeastern) bonebed, inasmuch as a great deal of the lower (southwestern) bonebed already had been sampled (meter-units 15-34). All the meter squares of the upper bonebed (except for 6-7 A) were excavated up to meter 4.

Once the excavation ended, screened caution tape and orange plastic fencing were laid over the bonebed exposed in the trench. An insulated copper wire running the length of the bonebed was also placed on the quarry floor. (The copper wire should permit relocation of the trench with a metal detector.) All this was then covered with several inches of screened sand. Next, additional sediment was shoveled over the trench to fill it at least to the level of the rest of the pad.

The specimens, field jackets, and some of the matrix were transported to Pasadena and a preparation laboratory was established. Contents of all the field jackets were prepared and removed, except for one small jacket that was partially prepared as an illustration of the density of the fossils in the bonebed. Approximately 50 gallons of sediment were screened and sorted. Prepared specimens were roughly identified, catalogued, and stored in numerical order of the meter squares. Representative specimens of nearly all taxa were sent to specialists for identification.

Results:

Over 1,200 vertebrate fossils were identified and catalogued into the UCMP collections. The 45/1 site bears the UCMP locality number "V99563." Hundreds of fossil mollusks were recovered from the screened matrix. Mr. Lindsey Groves, collection manager for Malacology, Natural History Museum of Los Angeles County (LACM), identified the snails. Dr. Howard Hutchison, museum scientist emeritus at UCMP, identified the testudine remains. Dr. Daniel Guthrie of the W. M. Keck Science Center of Pitzer, Scripps and Claremont McKenna colleges, identified the avian fossils. Dr. Xiaoming Wang, curator of vertebrate paleontology at the LACM, identified mammal remains of the order Carnivora. Dr. Thomas S. Kelly, research associate of the LACM, identified the horses and camels. The identified biota includes the following:

Plant Fragments

Mollusca

- Gryaulidae, *Helisoma* or *Gyraulus*
- Physa sp.
- *Cochlicopa* sp. or *Goniobasis* sp.
- Pupillidae
- Zonitidae

Crustacea

- ostracode

Vertebrata

- auran
- Masticophis or Coluber
- *Hesperotestudo* sp. of the *H. osborniana-orthopyga* lineage
- Branta cf. B. woolfendeni
- Anatidae
- Podicepidae
- passeriform
- lagomorph
- large rodent
- small rodent
- *Pseudaelurus marshi*
- Mustelidae, new genus and species
- *Martes* cf. *M. glarea*
- *Microtomarctus conferta*
- Larger borophagine canid genus
- *Amphicyon ingens*
- *Archaeohippus mourningi*
- *Desmatippus avus*
- *"Merchippus" californicus*
- *"Merychippus" brevidontus*
- *"Merychippus" relictus*
- cf. *Aphelops*

merycodontine antilocaprid
Miolabis sp.
large camel
proboscidean

Origins of the Bonebed:

Only two pair of bones were found in anatomical articulation or association. One is a second and an ungual (hoof) phalanx of a horse. These had been split longitudinally prior to deposition. The other pair represents two mandibles of *Microtomarctus* (UCMP 166203 & 166204). They were found in physical contact, but not in correct articulation. This means that the vertebrate animals preserved in the bonebed probably did not die near the time of the depositional event that entombed them. Enough time had to pass to allow the carcasses to decay and disarticulate. On the other hand, there was no definite indication of weather checking on the bones that were prepared. None of the bones show rodent gnaw marks, and no carnivore gnaw marks have been detected. However, the most common carnivores in the bonebeds are amphicyonids. Their habits were probably similar to those of hyenas. They probably consumed bones and would not leave much evidence of the gnaw-mark type. Perhaps they were responsible for some of the abundant bone splinters in the sediment. (It should be noted that no coprolites were observed in this quarry.) All these lines of evidence suggest that the bones did not lie exposed on the surface for an extended period of time.

Fish are conspicuous by their absence from this quarry. Even if fish bones could escape notice during quarrying, they should have been spotted during the screening and picking of 50 gallons of sediment. Ostracodes were recovered from that process, and fish bones are gigantic by comparison. The simplest explanation is that this was seasonal water, not permanent water. Freshwater snails are found in seasonal streams in the area, especially when springs along those streambeds support them during the dry season.

The horse remains show abundant evidence of adolescent animals. Many of the mandibles have deciduous teeth or have just begun wearing their adult teeth. Also, many of the horse limb bones have one epiphysis missing because it had not fused by the time of the animal's demise. High mortality in the young occurs in attritional assemblages, but the normally high percentage of young in a living population produces high percentages in catastrophic assemblages. It would require more detailed analysis of the age structure of the populations to determine whether the 45/1 quarry represents a taphocoenosis or a thanatocoenosis.

Significance of the Bonebed:

The fossils collected at 45/1 are the first terrestrial vertebrate fossils collected from the Temblor Formation in nearly 70 years. These are the first amphibian, lizard, tortoise, bird, terrestrial snail, and freshwater snail fossils from the Temblor Formation. **The**

tortoise shell is the most complete shell of a Middle Miocene tortoise ever found in California. The avian fauna is very important; there is no other nonmarine avian fauna of this age in California. **The grebe and songbird fossils are some of the earliest known in North America.** The only record of terrestrial carnivores known from the Temblor Formation until now consisted of isolated teeth; the 45/1 quarry produced jaws and skulls. The significance of a genus and species of mustelid new to science is obvious. This and the marten are the first mustelid remains from the Temblor Formation. Needless to say, there are no prior records of *Martes* in the formation.

The *Microtomarctus* is the first California record of that genus and species outside of the Barstow area and the westernmost record in North America. The *Pseudaelurus* is the first record of the family Felidae (cats) in the Temblor Formation. Even though many fossils of "*Merychippus*" *californicus* have been found in California and two other states, none of the fossils have ever shown the facial morphology of this horse species (*Figure 4*). This information is important for determining the correct genus to which the species should be assigned. Facial information from three specimens in this collection indicates it might belong to the genus *Acritohippus.*

Figure 4: Detail of Ex Situ Fossil Specimen

Base Conclusions About 45/1:

The bonebed at 45/1 is of Middle Miocene age (early Barstovian or late Hemingfordian NALMA), and it has produced many kinds of animals never seen before in the Temblor Formation and a few wholly new to science.

The depositional environment was terrestrial rather than marine.

The fauna is very similar to that of the North Coalinga local fauna described more than 70 years ago.

The affinities of the fauna lie more with Miocene faunas of the Columbian Plateau than with those of the Transverse Mountains or the Mojave Desert.

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