Tomb of Tar

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Tens of thousands of years ago, an asphalt seep in what is now the center of Los Angeles trapped hundreds of unwary animals. Excavating their remains creates a variety of challenges for paleontologists.

To most southern California residents, summer means long days spent at--or dreaming of being at--the beach. But to a small group of dedicated people, summer officially begins when the asphalt starts to melt. In tar-splattered tee-shirts and jeans they happily climb down into a black pit and inhale the rising fumes. Pit 91 at the Rancho La Brea "Tar Pits" is open for business.

The asphalt deposits of Rancho La Brea (Spanish for "tar ranch") are famous as the world's richest source of Pleistocene fossils. And of the more than 100 excavation sites sunk into the asphalt there, Pit 91 is one of the oldest and richest.

Asphalt seeps are found throughout the world around oil fields. Earth movement (such as California's frequent earthquakes) create cracks that allow crude oil and bitumen (asphalt) to escape to the surface. The volatile ingredients quickly evaporate leaving behind the thick, sticky sediment.

At the end of the Ice Age, when mammoths and saber-tooth cats roamed what is now the Los Angeles basin, the La Brea seeps were effective black death traps. The climate was cooler and rainier then, and streams were numerous. The asphalt oozed up from the ground, settling in the streambeds and other shallow depressions. But water, leaves and dirt often concealed the tar. When unwary animals waded in for a drink or stopped to feed, their feet became mired in the sticky pools, and they were trapped. As they struggled and screamed in terror they inevitably attracted predators, ever ready for an easy meal.

But more often than not the hungry carnivores became trapped, too, as they devoured their prey. Their angry snarls alerted still more predators.

Even the meat-eating birds could not escape entrapment. As they swooped to their meal, their wing feathers often dipped in the tar, making them unable to fly. They in turn became part of the feast.

As the bones became saturated with oil, they sank in the shallow pools. Leaves and sediments settled over the surface and asphalt continued to seep up from the ground. Gradually, the bones were buried. The cycle of entrapment, disintegration and burial has continued for almost 40,000 years.

Most of the tar pits were completely excavated between 1913 and 1915. Pit 91 was taken down about 10 feet. When the work was stopped, it was left open as an exhibit. But it gradually filled with asphalt and debris. In 1969, however, the pit was reopened, the excess asphalt removed and work started again. Today it is the only excavation of its kind taking place in the heart of a major city.

Every summer, the volunteers and the staff of the Natural History Museum and its satellite facility, the George C. Page Museum of La Brea Discoveries, work removing the asphalt and the valuable prehistoric record it contains. In the past 20 years they have excavated 13 feet of asphalt. George Jefferson, Assistant Curator and head of the Natural

History Museum's Rancho La Brea section, estimates they have at least five to seven feet more to go.

The excavation is worked only two months each summer, explains Jefferson. At that time the asphalt is warm and easier to work. Besides, if the dig were worked year round, the sheer volume of the fossils removed would overwhelm the storage facilities.

Tar pit paleontology is not glamorous. Pit 91 is about 25 feet square, its walls supported by steel beams and lined with black, tar-stained boards. The floor of the pit is continually covered with a thin layer of asphalt that seeps up along the pilings that support the walls. Volunteers remove approximately 80 gallons a week in a procedure they call, unromantically but descriptively, "glopping." They use trowels to scrape the asphalt from the floor of the dig, "glop" it into buckets and haul it up the ladder to the surface. They dump the excess into another nearby asphalt deposit, "where it's probably recycled right back into the pit," remarks Eric Scott, Chief Excavator for Pit 91.

The only spots of color in the pit are the orange hard hats worn by staff and volunteers and the bright yellow nylon cord strung across the bottom of the pit. The cord, just inches from the floor, divides the pit into three foot by three foot squares. Each square is excavated six inches at a time. Workers finish each level before going on to the next.

Before a fossil is removed from the asphalt, its location is noted by taking accurate measurements from two sides and the top of the square. Put into a computer later, the measurements will show exactly how each bone was oriented in the mass, giving scientists information on how the deposit was formed.

Sometimes, though, the fossils don't cooperate in the excavation process. Jefferson tells about finding the pelvis of a giant ground sloth that went into the floor through several six-inch levels. They removed it to prevent it from weathering, but that left a gaping hole in the floor of the pit. To prevent the asphalt on the sides of the hole from slumping in, which would have thrown off later measurements, the hole was lined with plastic and filled with Styrofoam packing material. It seemed like a good idea, says Jefferson, "but when the rains came, we found it bobbing and floating down there." They repacked the hole with sandbags.

This summer the crew is excavating the last square on the 13-foot level. Scott and a couple of volunteers kneel and sit on boards laid on the asphalt. They work carefully around each bone with small tools, dental picks and soft brushes. Lying close to the surface of the square is the skull of a saber-tooth cat that lost the battle for survival.

It may take days or weeks to excavate a six-inch-thick square depending on the amount of material in it. "We don't think in terms of time," says Scott. "We just think about removing each specimen as carefully as possible."

In their long history, the tar pits have captured everything from mice to mammoths, from seeds to giant ground sloths. Even one celled animals have been found in the dense asphalt. But when paleontologists started excavating the fossils in the early 1900's, they were primarily interested in museum quality specimens. They rarely saved specimens from animals smaller than a rabbit. Yet less than 1% of the specimens found in the deposits belong to large animals, says Chris Shaw, who is also Project Coordinator for Pit 91. "For every large bone we find, there are 200 to 500 specimens that belong to small animals and plants." Today all the fossils are retrieved, regardless of size. As a result, says Shaw, they have added 200 specimens to the list of animals known to have lived during the Pleistocene.

The spectacular skeletons of mammoths, mastodons, and saber-toothed cats draw the oohs and aahs of visitors to the George C. Page Museum. But according to Shaw, tiny "microfossils" tell more about environmental conditions on the prehistoric savannah than

all the mammoth bones put together. Birds and large mammals had large ranges that might cover a variety of environments and climatic conditions, he explains. But tiny animals such as mice and insects stayed within a few acres. They are much more accurate barometers of the climate in a localized area. Understanding the changes in climate may help scientists determine the factors that led to the extinction of much of the Pleistocene fauna.

So scientists handle the large fossils carefully, but they don't neglect the asphalt itself. They collect the excess material from each square, pack it in black cans and stack them near the edge of the pit.

Each pit has its own "personality," says Shaw. This is due primarily to the age of the pit, which can range from a mere few thousand years old to Pit 91's venerable 38,000 years. But in some cases the character of the pit is due to the different formation of the deposit. For example, Pit 9 contained almost 90% of all the mammoth and mastodon bones found at Rancho La Brea. Shaw believes that the original pool must have been larger and deeper, and more attractive to the ancient elephants. "Elephants love to wallow," he points out.

The most recent deposit to be uncovered formed very differently from the others at Rancho La Brea. It was flat, not conical and only one and a half to two feet thick. Shelley Cox, Laboratory Supervisor, says it appears the asphalt flowed down into a depression to fill a pool. It was probably not the site of an upwelling of asphalt.

The deposit was found when ground was broken for the Page Museum in 1977. Construction crews were standing by; there was no time to do a slow, methodical excavation. But because of the formation, scientists were able to remove 20 large blocks, wrap them in newspapers and pack them in plaster-saturated burlap. One by one they are being "excavated" in the Page Museum laboratory.

One of the plaster-encased blocks, roughly 4’x 3’x 2’ sits in the middle of the lab now. The top has been sliced off. Poking through the surface are the broken ribs of saber-tooth cat and the claw and partial skeleton of an eagle. Its other secrets remain hidden in the asphalt. "It's a real treasure chest," says Cox.

Out in Pit 91, excavators take measurements manually with a ruler. But the procedure in the lab more closely resembles a hospital monitoring system. A metal framework is attached to the ceiling above the block of asphalt. At each corner is a microphone. Sitting close by is a computer.

Using a sonic probe Cox touches the fossil she wants to mark. The probe emits a sound that is picked up by the microphones. The computer analyzes the distance the sound travels to each of the four mikes and plots the exact position of the bone in the block.

After all the fossils have been marked and removed, the computer can generate three-dimensional graphics showing the position and relationship of every bone in the asphalt block. In effect, the scientists will be able to pick the block up, turn it, and look at it from different angles as if the asphalt had never been there.

Nicknamed the "fishbowl" by the staff, the laboratory is a glass-walled room in a corner of the museum hall. All day children and adults stand with their noses pressed to the windows watching the work inside.

Most of that work is done by a spectrum of volunteers from high school juniors to retirees. They patiently clean, sort, label and piece together the innumerable scraps of caramel-colored bone. Shelley Cox seems to be everywhere, answering questions, giving advice, or teaching new techniques.

In one area, two teenage girls separate specimens from boxes of broken and unidentified bones from the early excavations. The boxes may contain a slip of paper

giving the pit number and collection date, but little else is known about them. The volunteers sort them into piles of teeth, pieces of jaw and a large pile Cox refers to as the "I-don't-knows."

With all the new material coming from Pit 91, it hardly seems worth the trouble to clean 80 years of dust from these leftovers, but it is. Tucked away unnoticed in the boxes, Cox says they have discovered the remains of a second type of saber-toothed cat called *homotherium* and a smaller kind of horse. Both were previously unknown west of the Rocky Mountains.

Another volunteer, oblivious to the faces at the window, gently turns, twists and tries, with infinite patience, to match broken fragments of bone. Lying next to his elbow is a carefully reconstructed rib, systematically wired together.

Using a magnifier another volunteer is sorting the microfossils from the asphalt matrix of Pit 91. After the asphalt is dissolved away, it leaves a pile of what looks like coarse sand. Most of it is just that. But the volunteer's skilled hands and eyes effortlessly separate tiny freshwater shells and miniscule bones, fragments of insect carapaces and plant material from the gravel. "After a while you know what to look for," says Cox.

One of the most striking characteristics of La Brea's fossils is the quality of the preservation of the bones. Unlike many types of fossils, these bones have not been replaced by dissolved minerals. They have been preserved by the saturation of oil. They show all the detail that would be found on them if the animal had died only recently, including marks where muscle were attached and blood vessels passed. In broken bones, the spongy marrow is distinctly visible, each cell of tissue filled with oil. "We're *very* spoiled," says Cox.

The asphalt saturates the bones so completely it has even preserved the amino acids and DNA, says Shaw, who would apparently give a lot to see a live saber-tooth cat. "The next thing we're going to do is start cloning them," he says with a wicked glint in his eye.

But La Brea comes with its own brand of problems, too. Most of the animals that died in the tar met violent ends. Their bones were often dragged off and gnawed. Prehistoric winter rains washed the loose bones downstream to other locations.

Even after they were entombed in tar, the bones did not stop moving. The asphalt moves when it gets warm, and energetic bursts of gas and oil coming up from the ground stir it up even more. As a result, the bones of all the animals at La Brea are jumbled together leaving scientists with an incredible jigsaw puzzle.

Most of the complete skeletons on display in the George C. Page Museum, says Cox, can contain bones from almost as many animals as the skeleton has bones. One reconstructed saber-tooth cat's paw displayed in the laboratory window is made up of bones taken from at least six different pits.

But despite the jumble, the patient paleontologists at Rancho La Brea are gaining vivid insights into life on the California plain at the end of the Pleistocene.