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# THE LA BREA TAR PITS

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Located in the heart of downtown Los Angeles, in the Miracle Mile district and next to the Farmers' Market are the La Brea Tar pits, also sometimes referred to as the Rancho La Brea Tar Pits, The Tar Ranch. If the taxi driver does not know where they are just mention the Page Museum because the Tar Pits are right next to it.

The word 'Brea' means tar in Spanish. If one translates 'The La Brea Tar Pits' into the English language the translation would be 'The The Tar Tar Pits'! (An example of pleonasm.)

For the past 40,000 years asphalt has been oozing and bubbling to the surface from the extensive oil deposits below the surface of the Los Angeles basin.

First discovered by white men in 1769, this cluster of some 100 Tar Pits in the middle of the city, now known as Hancock Park, is home to over three million fossils, most of them in pristine condition. This site is one of the world's most famous locations to study an exceptionally diverse assemblage of extinct Ice Age plants and animals of the Pleistocene epoch.

The Tar Pit fossils are a window into life in southern California from 40,000 to 8,000 years ago.

After the American Civil War the true economic value of the area was realized and in the 1870s the industrial exploration of oil and the mining of asphalt had began.

Observant visitors to the City of Los Angeles may have marvelled at the many 'Nodding Donkeys' pumping oil from within the city boundary and the surrounding urban landscape.

The Los Angeles basin is a coastal, sediment-filled plain, rich in petroleum and is home to the state's largest oil and gas fields. Oil and gas migrate upward from these underground fields to form extensive oil and gas seeps in the area.

The basin is located between the peninsula and transverse ranges in southern California, containing the central part of Los Angeles and parts of the Orange counties. The basin is bounded by the Santa Monica Mountains, the Puente Hills and the Santa Ana Mountains. The Palos Verdes Peninsula marks the outer edge of the basin along the coast.

The sediment in the basin is up to 11 km deep and was formed during the Miocene and Pliocene Epochs of the Tertiary approximately 15 million years ago, whilst the area of Los Angeles and Rancho La Brea lay beneath the surface of the Pacific Ocean. The underlying crustal weakening resulted in the formation of a large bowl within

the basin and sediments from the sea and rivers built up in thick layers in such a deep depression on the ocean floor.

The accumulation of micro-organisms and plant remains during this time is believed to be the source of the large deposits of oil in the Los Angeles basin.

The sedimentary character of the basin is the principal reason why it is considered especially susceptible to excessive damage during earthquakes. The basin is often compared by geologists to a 'bowl of jelly' that can shake violently when driven by seismic activity of the San Andreas Fault system.

Its loose rock structure has also led to numerous instances of subsidence as a result of oil extraction, the most spectacular examples being the Baldwin Hill dam collapse in 1963 which claimed several lives and caused considerable damage in the area due to flooding. Baldwin Hills is a district in south-western Los Angeles.

Just as spectacular was the sinking of the Long Beach harbour floor in the San Pedro Bay by several metres. It may be of interest to note that the former cruise liner, the Queen Mary, is now tied up next to Long Beach Harbour.

About 5 million years ago, the crustal stretching subsided and the ocean floor of the basin was forced to the surface. Additional sediments of sand, gravel and clay from the erosion of emerging hills accumulated on top of the much older oil-rich marine deposits during the upswell resulting in the floor of the basin as it exists to-day.

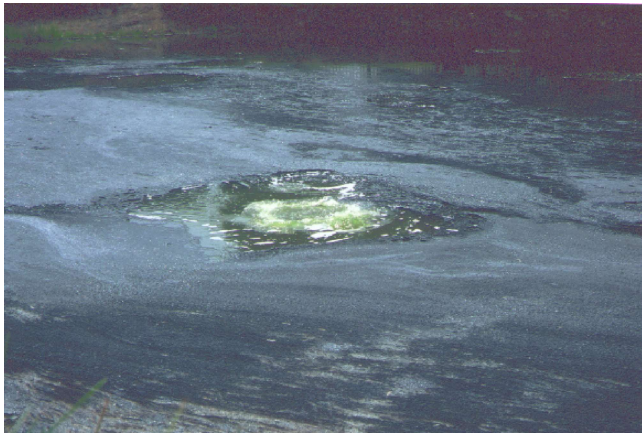
Further erosion from the surrounding hills continued to form new layers of sediments on top of the older ones and over tens of thousands of years produced the cone-shaped asphalt deposits found at the Rancho La Brea Tar Pits.

Although commonly called Tar Pits, the liquids that seep out of the ground at Rancho La Brea are actually comprised of asphalt, not tar. These two names can sometimes lead to confusion. Tar is a commercial by-product made by the distillation of woody materials such as coal or peat while asphalt is a naturally formed substance comprised of hydrocarbon molecules and is the lowest grade of crude oil.

Asphalt seeps like those at Rancho La Brea are rare. The Tar Pits form when crude oil oozes to the surface through conduits and fissures in the Earth's crust. The light fraction of the oil evaporates, leaving behind the heavy tar, or asphalt, sometimes also referred to as bitumen, which accumulates as a sticky, dense, heavy and highly viscous liquid in lakes or pools or oozes out anywhere in small patches on the ground just like thick, black treacle.

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Huge bubbles can be seen puncturing the surface of these asphalt pools, *photograph 1*. This is methane gas - commonly called natural gas. It is colourless and odourless, the same substance as used in gas-burning home appliances. Gas companies add an odour to the gas for safety reasons. Methane is a by-product created when plant and animal remains decompose to form crude oil.



*Photograph 1: Methane can be seen bubbling from one of the Rancho La Brea Tar Pits*

Oil seeps also build up impressive large patches of asphalt at the base of cliffs. A good example can be seen near Santa Barbara at the northern margin of the Los Angeles basin.

These deposits are continuously eroded by wave action to form so-called 'tar balls' on the sandy beaches, which are then carried by longshore currents to other beaches on the Pacific coast, much to the annoyance of locals and holiday makers.

Due to the rapid expansion of the City over the last two hundred years, many buildings in the Los Angeles Basin are now affected by oil, asphalt and methane which seeps slowly through their foundations. Special ventilation equipment can take care of the gas, but the oil and tar seeps are more difficult to deal with.

With its numerous asphalt seeps, Rancho La Brea would have been a hazardous place for animals that roamed in the Los Angeles Basin.

This was especially true during the warmer seasons. As the semi-solid asphalt turned softer and stickier, it provided optimum conditions for entrapment. Leaves, plant remains and rain water would cover the surface and partially obscure the pits from view but leaving some areas free of debris which made the surface appear like watering holes.

Wandering animals would often pass by and unknowingly venture into the camouflaged asphalt to drink or just walk across. If the conditions were right the animals might become trapped like a fly on flypaper. The feet and legs of heavier animals might sink three or four inches below its surface. Depending on the time of day or year, strong,

healthy animals may have managed to escape but others would have been held fast until they died of exhaustion. The stranded animal would have become easy prey for the many carnivores that lived there.

Not likely to pass on a free meal, they would attack the mired animals and even each other. After an intense struggle over the helpless prey, some of the attacking predators would become trapped as well. In turn, other scavengers would then try to feast on those trapped anew and also risk sinking to their death into the sticky asphalt.

This was a classic case of the biter being bitten progressively right down through the food chain, *photographs 2 and 3*.



*Photograph 2: Life-size replicas of a mammoth family. The mother has become trapped in the asphalt. Her mate and offspring watch helplessly.*

It was here that huge mammoths, bison, fierce sabre-toothed cats, wolves and giant ground sloths, along with birds and countless other smaller animals, became trapped and entombed in the asphalt that has been seeping out of the ground for the past 40,000 years.



*Photograph 3: Predators fight over the prey*

But the La Brea tar pits are not only best known for the large number of mammal fossils from the last ice age which have been found there but also for the fossilized insects and plants, pollen grains and micro-organisms.

In today's eco-systems, herbivores are much more abundant than carnivores. It is therefore curious that at Rancho La Brea about 90% of the mammal fossils found represent carnivores. Ten predators have been recovered for each prey animal. Most of the bird fossils are also predators or scavengers, including vultures, condors, eagles, and giant extinct stork-like birds known as teratorns.

Such preponderance of carnivores might be explained by the fact that one large animal mired in the Tar Pit could take many other predators with it – for example, a pack of wolves. It was a tragic ending for many pre-historic creatures but a boon for today's paleontologists studying the last ice age.

However, entrapment was not a daily event. If only one large animal became trapped in the asphalt every 10 years over a period of 30,000 years, it would more than account for the millions of bones recovered from the asphalt at Rancho La Brea.

The unusual high quality of fossil preservation at Rancho La Brea occurred because the bones were buried rapidly by the asphalt and sediments. That is not to say that the bones were buried overnight, but they were seldom exposed to elements for an extended length of time. Those that were exposed to natural processes like erosion, for an extended amount of time usually failed to be preserved as fossils.

After the animal remains decayed, the bones became saturated with asphalt and partially or wholly submerged in the seep. After partial burial, winter and spring rains would wash down fresh sediments that mingled with further seepage. It is this cycle, repeated for tens of thousands of years which contributed to the formation and composition of the fossil deposits.

Animal tissues and organs such as flesh, hair, cartilage, claws and feathers have not been recovered from Rancho La Brea. Several types of bacteria helped decompose these materials before complete burial within the asphalt and sediment layers occurred.

No dinosaurs have ever been recovered from the Tar Pits. Dinosaurs became extinct 65 million years before the asphalt started trapping animals in this part of the Los Angeles Basin.

There are more than one hundred Tar Pits in the Hancock Park area. Pit 91, which is roofed over, continues to be regularly excavated, however, for only two months each summer - end of June to beginning of September. Visitors can watch from a special observation platform how paleontologists and volunteers recover fossils from the

sticky asphalt 14 feet down below. It is extremely dirty work.

Patches of sticky asphalt are everywhere even in the 'protected' viewing area as well as around the pit on the outside and on adjacent walkways and tracks. There are seepages throughout the park and great care is required whilst exploring the area.

Any visitors who have a week to spare during their stay in Los Angeles can participate in the excavations and can also help with the further processing in the laboratory. However, be warned, a chimney sweep looks clean in comparison with the excavators of tar pit 91! The work in the laboratory is, in some cases, much cleaner.

The excavated material is boiled in a solvent to remove most of the asphalt. The cleaned material is a mixture of sand, small pebbles, fossils and small pieces of large fossils and micro-fossils, such as seeds. The next stage is the laboratory where visitors can watch paleontologists and volunteers, in a glass-enclosed area, cleaning the fossils by hand, using dental tools and a solvent to remove the remaining asphalt.

Micro-fossils are retrieved from their matrix of asphalt and sandy clay by washing with a solvent to remove the oil, then picking through the remains under a high powered lens. Small or fragile specimens are cleaned in ultrasonic tanks, where high-frequency sound waves remove the last speck of sticky and sandy deposit.

Each fossil, stained in various shades of brown by the saturation of asphalt over a long period, is given a protective coating and an individual number. The material is then identified, labelled, catalogued and stored with the thousands of other fossils recovered from the Tar Pits.

There are at least 59 species of mammal and over 135 species of birds in addition to insects, molluscs and plants. Over 660 species of organisms in all. The material is available for further study and research by professionals and students from around the world.

Each specimen found in Pit 91 and other pits makes it possible to piece together the giant puzzle from the past to understand what life was really like in ancient times where Los Angeles stands today.

Outside the Page museum, in Hancock Park, are life-sized fibre-glass models of a Columbian mammoth family which stand at the east end of the tar lake and there is also a life-sized model of an American mastodon near the west end of the tar lake.

Some really outstanding and fascinating displays in the Page museum tell the story of the Rancho La Brea Tar Pits and recreate the conditions of how animals became stuck in the sticky asphalt which in the end became their oily grave.

About 20 gallons of asphalt a day still oozes and bubbles to the surface throughout Hancock Park in addition to the asphalt accumulation in the 'tar lakes'. Insects and worms are occasionally trapped as well as birds, mostly pigeons, but also hawks egrets, ducks doves and sparrows. Small rodents and rabbits also fall victim to the sticky ooze.

During warm days, when the asphalt is softest, dogs and even humans have been known to get trapped. The latter of course are rescued before they sink out of sight to join the millions of fossils still to be recovered from the bottom of the Rancho La Brea Tar Pits.

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## GEOLOGICAL HOWLERS

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The following statements made the examiners giggle:-

### **EARTHQUAKE SHAKERS:**

- Earthquakes can be stopped by bombing the faults.
- Earthquakes sometimes cause buildings to liquify.
- Earthquakes can occur in water, where landslides trigger a tsunami on the ski slopes.
- S waves don't reach station Y, because they can't travel through solids.

### **POOR SPELLING:**

Candidates often cause funnies due to spelling:

- the decomposition of conglomerate (think they meant deposition!).
- Weathering and erosion whore away igneous rocks.
- Slike and slides, slikkenslides.
- Lots of different spices are whipped out (do they mean lots of different species are wiped out?).

### **METAMORPHISM MISTAKES:**

- The spotted rock has been metamorphosed by the black shale, shale is cooled quickly and graptolites are trapped easily.
- Slate starts off as granite.
- Local metamorphism and continental metamorphism.
- The platonic metamorphic aureole (very friendly!).
- Metamoetism (that's the champagne-type metamorphism!).

### **STRUCTURAL, MAPPING AND DEFORMATION:**

- The folding is normal, made up of anticlines and declines.
- The type of fault seen in the diagram is
  - an anticline
  - an unconformity
  - igneous intrusion.

- In response to "What is solid geology?"
  - geology with solid evidence to prove that whatever is stated is true
  - not liquid or gas geology
  - abiotic part of the ecosystem
  - rock deposited years ago
  - what there is to see. Nothing is geofantasy!
- Rock X is more docile (ductile?).
- Type of strain: mild and intense.
- The subsidence was created for the M6 motorway.
- There is a lot more geology in grid square 4459.

### **FOSSIL FROWNS:**

- Trilobites were still being fossilised in the Jurassic, even though they had been extinct before then.
- The idea of trilobites moulting is very far fetched.
- In labelling the glabella of a trilobite, the following answers were seen:
  - flagella
  - nose
  - headcase
  - gelaba.
- The colour of the fossils will change over time, mainly because the chemicals in the ground will interfere.
- In labelling the septa of a coral, various alternatives were:
  - stem
  - theca
  - corona
  - segments
  - spoke
  - thatches
  - and our favourite.... frongs.
- Graptolites:
  - are palargic
  - are informal
  - involve from pendent to scandent.

### **MISCELLANEOUS MISTAKES:**

- Uniformitarianism is the past is the key to the present.
- Alternative names for radiometric dating:
  - Mother and daughter counting
- During the Tertiary, NW Scotland experience voluptuous outpourings of lava.
- Ophiolites are brought in by the tide and move by surge processes.
- Oceanic crust can be abducted.
- Olivine is kept in suspense.
- Due to waddy-waddy - a river washing out of the coal bed.
- Name a type of igneous rock:
  - sandstone
  - limestone.
- Water will be contaminated by leaches (confusion with leachate?!).
- Intoxicated water can flow into limestone joints.