

Messel pit

The **Messel Pit** (German: *Grube Messel*) is a disused quarry near the village of Messel, (Landkreis Darmstadt-Dieburg, Hesse) about 35 km (22 mi) southeast of Frankfurt am Main, Germany. Bituminous shale was mined there. Because of its abundance of fossils, it has significant geological and scientific importance. After almost becoming a landfill, strong local resistance eventually stopped these plans and the Messel Pit was declared a UNESCO World Heritage site on 9 December 1995. Significant scientific discoveries are still being made and the site has increasingly become a tourist site as well.

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History

Brown coal and later oil shale was actively mined from 1859. The pit first became known for its wealth of fossils around 1900, but serious scientific excavation only started around the 1970s, when falling oil prices made the quarry uneconomical. Commercial oil shale mining ceased in 1971 and a cement factory built in the quarry failed the following year. The land was slotted for use as a landfill, but the plans came to nought and the Hessian state bought the site in 1991 to secure scientific access. In the few years between the end of mining and 1974, when the state began preparing the site for garbage disposal, amateur collectors were allowed to collect fossils. The amateurs developed the "transfer technique" that enabled them to preserve the fine details of small fossils, the method still employed in preserving the fossils today.^[1]

Messel Pit Fossil Site

UNESCO World Heritage site



Location	Darmstadt-Dieburg, Hesse, Germany
Criteria	Natural: (viii)
Reference	720bis (http://whc.unesco.org/en/list/720bis)
Inscription	1995 (19th Session)
Extensions	2010
Area	42 ha (4,500,000 sq ft)
Buffer zone	22.5 ha (2,420,000 sq ft)
Coordinates	49°55′03″N 8°45′24″E



Location of Messel pit in Hesse.

- ☒ Show map of Hesse
- ☐ Show map of Germany
- ☐ Show all

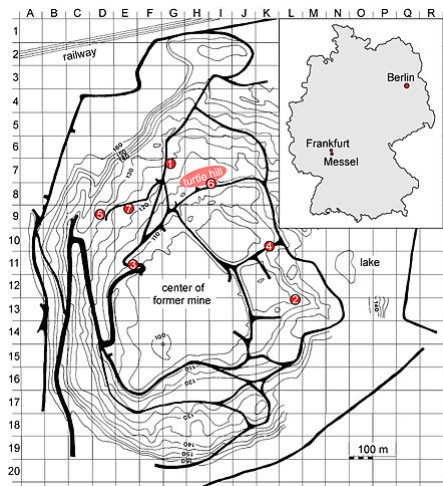
Due to the extraordinary fossils, the pit was declared a UNESCO world heritage site in 1995, one of the few sites that have ever been placed on the list exclusively due to fossils.^{[2][3]}

Many of the known specimens from the site have come from amateur collectors and in 1996, an amnesty on previously collected fossils was put in effect, in the hope of getting privately owned collections back into public ownership and available to science.

Depositional characteristics



Outcrop of the Messel oil shale near the center of the pit.



Inset map shows the location of the town and fossil locality of Messel near Frankfurt in the southwestern part of Germany. Larger map shows the locations of Messel primates 1–7 (Table 1) within the Messel oil shale excavation.

The current surface of the Messel pit is roughly 60 m (200 ft) below the local land and is about 0.7 km² (0.27 sq mi) in area. The oil-shale bed originally extended to a depth of 190 m (620 ft).^[4] 47 million years ago in the Eocene when the Messel deposits formed, the area was 10° further south than it is now. The period was very close to the Paleocene–Eocene Thermal Maximum and the climate and ecology of the site were very different. A large series of lakes, surrounded by lush sub-tropical forests supported an incredible diversity of life. The Messel lake bed was probably a center point for drainage from nearby rivers and creeks.

The pit deposits were formed during the Eocene Epoch of the Paleogene Period about 47 million years ago, based on dating of basalt fragments underlying fossilbearing strata.^[5] Oil shale, formed by the slow anoxic deposition of mud and dead vegetation on



A fossil of the primitive mammal *Kopidodon*, showing outline of fur

the lake bed, is the primary rock at the site. Its sediments extend 13 m (43 ft) downward and lie atop an older sandstone foundation. The fossils within the shale show a remarkable clarity and preservation due to the unique depositional characteristics of the lake and so the Messel pit represents a Konservat-Lagerstätte. The upper stratifications of the lake most certainly supported a variety of organisms, but the bottom was subject to little disturbance by current, spawning a very anoxic environment. This prevented many epifaunal and infaunal species from inhabiting this niche and thus bioturbation was kept at a minimum. Overturn of the lake layers (caused by seasonal variations) lowered oxygen content near the surface and led to a periodic "die-off" of aquatic species. Combined with a relatively low rate of deposition, 0.1 mm (0.0039 in) per year, this provided a prime environment for the preservation of fauna and flora.

Volcanic gas releases

The area around the Messel Pit is believed to have been geologically and tectonically active during the Eocene. Leading scientists hypothesize that events much like the 1986 volcanic gas releases at Lake Nyos, Cameroon could account for the large deposition of non-aquatic species. Periodic subsurface shifts possibly released large concentrations of reactive gases (such as carbon dioxide and hydrogen sulfide) into the lake and adjoining ecosystems, killing susceptible organisms. During these releases, birds and bats might have fallen in if near the lake surface and terrestrials could be overwhelmed when near the lake shore. Since the lake was very deep, animals that fell in it drifted

downwards into oxygen- and bacteria-poor water, where they were preserved remarkably well, being overlaid by successive layers of mud that petrified later, thus producing an aggregation of fossils of exceptional quality, quantity, integrity, and variety.

Fossils

The Messel Pit provides the best preserved evidence of Geiseltalian flora and fauna so far discovered. Most other sites are lucky to contain partial skeletons, but Messel boasts extensive preservation of structural integrity, even going so far as to preserve the fur, feathers and "skin shadows" of some species. Unusual preservation has sparked some closely reasoned interpretations. The symptomatic "dumb-bell"-shaped bite marks on either side of the leaf vein on a fossilised leaf have been identified as the death-grip of a carpenter ant terminally parasitized by the fungus *Ophiocordyceps unilateralis*, that, apparently then as today, commandeered its behavior, in order to release its spores from a favourable location; it is the earliest concrete sample of fungal behavioural manipulation.^[6]



Splitting the shale with a large knife to reveal fossils.

The diversity of species is remarkable partly as a result of the hypothesized periodic gas releases. A brief summary of some of the fossils found at the site follows:

- Early primate fossils
- Nine mating pairs of fossil turtles have been found. The turtles, *Allaeochelys crassesculpta*, were *in coitus* (in the act of having sex).^[7] They are male-female pairs, with the male's tail tucked under the female, which is how they copulate. Their death must have been rapid. It is supposed that the turtles had started mating in the aerated surface waters of the ancient lake. As they sank into deeper water, they were overcome by the release of toxic volcanic gas. They were then buried in the lakebed sediment.^[8] Turtles belonging to this clade are still living. They have lost their reptilian scales, and their skin absorbs oxygen from the water. Normally, this is an advantage: it helps them stay submerged for long periods. However, under anoxic conditions it is a disadvantage, because carbon dioxide and dissolved poisons are absorbed as well.^[8]
- Over 10,000 fossilized fish of numerous species
- Thousands of aquatic and terrestrial insects, some with distinct coloration still preserved
- Innumerable small mammals including pygmy horses, large mice, primates, ground dwellers (hedgehogs, marsupials, pangolins), aardvark relatives and bats.
- Large numbers of birds, particularly predatory species.
- Crocodiles, frogs, turtles, salamanders and other reptiles or amphibians
- Remains of over 30 distinct plant species, including palm leaves, fruits, pollen, wood, walnuts and grapevines

The following is only a partial list:

Mammals

Darwinius masillae, identified in 2009 as an adapiform primate
Kopidodon, an extinct arboreal cimolestan
Leptictidium, an extinct omnivorous hopping mammal (of the leptictid family)
Propalaeotherium, an early relative of horses
Ailuravus, a rodent
Peradectes, a metatherian
Palaeochiropteryx, a bat
Lesmesodon, a small hyaenodontid
Eomanis, an early pangolin
Eurotamandua, a scaleless, anteater-like pangolin
Europolemur, a primate
Paroodectes, an early carnivorous mammal

Pholidocercus, an early hedgehog
Macrocranium, an early long-tailed hedgehog
Masillamys, an early rodent
Messelobunodon, an early artiodactyl
Godinotia, an early primate
Buxolestes, a semiaquatic, otter-like cimolestan

Birds

Palaeotis, an early struthionid
Strigogyps sapea (formerly *Aenigmavis*) a cariamiform
Messelornis, the Messel-bird; a species of gruiform
Masillastega, a freshwater silurid
Lapillavis, a possible trogonid relative
Cypseloramphus, a basal apodiform
 The Messelasturidae (*Messelastur* and *Tynskya*),
 carnivorous relatives of modern parrots
Palaeoglaux, an early owl with enigmatic breast feathers
Paraprefica, an early potoo
Paraortygoides, a galliform^[9]
Masillaraptor, an early falconiform
Parargornis, an early apodiform
Messelirrisor, a tiny bucerotiform closely related to
 hoopoes and wood-hoopoes
Selmes (an anagram of "Messel"), a mousebird with
 stubby toes
Gastornis (formerly *Diatryma*), a large, flightless
 anseriform
Hassiavis,^[10] a member of Cypselomorphae
Quasisyndactylus,^[10] a member of Alcediniformes
Valonimicola, a possible charadriiform^[11]
 A currently unnamed lithornithid, a sandpiper-like
 paleognath, the first record of its kind in Middle Eocene
 Europe.^[12]



Darwinius masillae (holotype)
 showing the remarkable
 preservation at Messel.



Masillamys at the Senckenberg
 collection

Reptiles

Asiatosuchus, a large crocodile
Diplocynodon, an alligator
Hassiacosuchus, a durophagous crocodile
Palaeopython, a snake
Cryptolacerta, a lizard with affinities to amphisbaenians
Geiseltaliellus, a lizard with affinities to Corytophaninae
Allaeochelys crassesculpta, turtles



Early perch *Palaeoperca proxima*

Fish

A bowfin, variously described as *Amia* (the modern genus) or *Cyclurus*
Amphiperca, an early perch
Palaeoperca, another early perch
Atractosteus, a gar
eel

Insects

Casaleia eocenica

Cephalopone - *Cephalopone grandis* and *Cephalopone potens*

Cyrtopone - *Cyrtopone curiosa*, *Cyrtopone elongata*, *Cyrtopone microcephala*, and *Cyrtopone striata*

Gesomyrmex pulcher

Messelepone leptogenoides

Pachycondyla eocenica

Pachycondyla lutzi

Pachycondyla? *messeliana*

Pachycondyla parvula

Pachycondyla petiolosa

Pachycondyla petrosa

Protopone - *Protopone?* *dubia*, *Protopone germanica*, *Protopone magna*, *Protopone oculata*, *Protopone sepulta*, and *Protopone vetula*

Pseudectatomma - *Pseudectatomma eocenica* and *Pseudectatomma striatula*

Titanomyrma gigantea

Titanomyrma simillima



Fossil jewel beetle, still showing colour of the exoskeleton

Plants

Ailanthus confucii, tree of heaven

Anacardium germanicum, cashew tree

Camelliacarpoidea messelensis, Messel *camellia*

Canarium, member of the incense tree family

Cyclanthus messelensis, panama hat family

Myristicacarpum, member of the nutmeg family

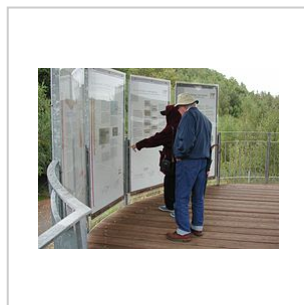
Darmstadtia biseriata, a member of the trumpet creeper family Bignoniaceae

Mytilaria boglei, witch-hazel family

Sloanea messelensis, Elaeocarpaceae

Access

Exhibits from the pit may be seen in the Messel town museum,^[13] the Museum of Hessen in Darmstadt (5 km from Messel)^[14] and also the Senckenberg Museum in Frankfurt-am-Main (some 30 km from Messel).^[15] Casual visitors can park close to the pit and walk around 300 m to a viewing platform overlooking the pit. Entrance to the pit is only possible as part of a specially organized tour.



See also

- Lagerstätte
- List of fossil sites (with link directory)

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External links

- Official site (<http://www.grube-messel.de/>)
- Messel Fossils (<http://palaeo.gly.bris.ac.uk/Palaeofiles/Lagerstätten/Messel/fossils.html>)
- Missing Link Found at Messel Pit? (<https://www.theguardian.com/science/2009/may/19/ida-fossil-missing-link>)

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