



Earthquake!

HOW THE EARTH SHOOK THE PAST

When earthquakes strike, the consequences can be catastrophic. Yet what do we really know about their impact on past cultures? All is revealed in **Andrew Robinson's** latest unputdownable book *Earth-Shattering Events: Earthquakes, Nations and Civilization*.

Great earthquakes can affect the course of world history. In the 20th century, the seismic destruction of the Japanese capital Tokyo in 1923 was a key factor in the subsequent militarisation of Japan, while the devastation of the Chinese industrial city Tangshan in 1976 catalysed the end of the Cultural Revolution and the subsequent economic development of China. Earthquakes must have been influential, too, in the ancient world. Yet the further back in time we look, the harder it is to

detect an earthquake and its signature. Disappointingly, there is almost no clear account of seismicity in some 3,500 years of ancient Egyptian inscriptions and papyri, beginning around 3000 BC, because Egypt has low seismic activity. The first reliable reports of earthquakes date only from 780 BC in China, 464 BC in Greece, 461 BC in Italy, AD 599 in Japan and as late as 1567 in the Americas (in Mexico), although there is a report in the ancient Chinese *Bamboo Annals* of the shaking of Taishan mountain in Shandong province as early as 1831 BC.

Archaeology provides further, less definite, evidence for earthquakes in earlier periods. Dholavira, a site in Gujarat belonging to the Indus civilisation dating from the late 3rd millennium BC, shows slip faults in sections and displacement of architectural features, subsequently repaired by the town's occupants, suggesting an ancient earthquake. A Minoan temple at Anemospilia, not far from Knossos, destroyed by fire around 1700 BC, yielded the skeletons of what appeared to be a priest and his female acolyte and, on the temple's altar, a

LEFT Earthquakes have been particularly harsh on Japan. The Great Ansei earthquake of 1855, shown here, severely damaged the Japanese capital Edo (Tokyo) through shaking and fire. It also catalysed the end of Japan's long political isolation and its opening up to Western trade and influence, following the visits of the US naval commander Commodore Perry in 1853 and 1854.

young man lying on his side, probably once bound hand and foot, with a large ceremonial bronze knife lying on his bones. Forensic examination suggests that he was in the midst of being killed by the priest when an earthquake struck – possibly as a sacrificial offering in response to foreshocks, intended to avert a greater shock, as the excavators grimly speculated.

Shaking creation myths

Also significant, though even less conclusive, are mythological traditions, which may transmit the experience of earthquakes from still earlier times. The majority of earthquake creation myths involve animals. In Japan, where earthquake mythology was at its most sophisticated, earthquakes came to be symbolised by a dragon, which then morphed into a large cosmic fish, and finally became a mischievous giant catfish, known as a *namazu*, who lived in the mud beneath the earth. The *namazu* was normally restrained by a god who protected Japan from earthquakes by keeping a mighty rock on the creature's head. The supposed rock can be seen at Kashima, a place about 100 kilometres from Tokyo that has remained comparatively free from earthquakes. However, the Kashima god occasionally had to leave his post in order to confer with other gods. At such times the *namazu* was licensed to twitch its barbels, writhe around, and generally play pranks – with disastrous results for human beings on the surface. The mythology is brilliantly and humorously depicted in coloured woodblock prints, known as *namazu-e*, first created after a major earthquake near Edo (modern Tokyo) in 1855. Nowadays, images of catfish appear in emergency earthquake-preparedness programmes in Japan, such as the Earthquake Early Warning logo of the Japan Meteorological Agency.

Despite the predominance of animals in earthquake myths, some cultures prefer to give the earthquake human form. In Classical Greece, Poseidon,

RIGHT A mischievous giant catfish, the *namazu*, symbolises the cause of the Great Ansei earthquake, which destroyed Edo's red-light district in 1855. As the courtesans attack it, profit-minded artisans dash to its rescue.



EARTH-SHATTERING EVENTS

ABOVE The further back in time we look, the harder it is to detect evidence for earthquakes. However, in this Minoan temple at Anemospilia, destroyed by fire around 1700 BC, archaeologists found grisly evidence for a sacrificial ritual possibly conducted in response to earthquake foreshocks.

whether or not they were associated with escaping vapours.

Quake ye sinners

By the time that the Bible came to be written in its final form, natural and supernatural interpretations of earthquakes were inextricably entwined. Are biblical earthquakes metaphorical or might they refer, in some cases, to geological earthquakes? As with all attempts at linking biblical events with history, the answer is bound to be uncertain and controversial. >





In the New Testament, at the Crucifixion, 'Jesus again gave a loud cry, and breathed his last. At that moment the curtain of the temple was torn in two from top to bottom. There was an earthquake, the rocks split and the graves opened.' Matthew's description may have been inspired by the 31 BC earthquake that damaged the temple in Jerusalem, as well as Herod's palace in Jericho. At the Resurrection of Jesus from his tomb, 'Suddenly there was a violent earthquake; an angel of the Lord descended from heaven; he came to the stone and rolled it away, and sat himself down on it.' Here the supernatural element evidently predominates, although the shaking of a real earthquake could have dislodged a tombstone by natural means.

The infamous destruction of the cities of Sodom and Gomorrah in the book of Genesis is regarded as punishment for moral transgressions. Even so, it may have referred to an earthquake, at least in part. An earthquake and fire seem to be implied by the statement that the Lord 'overthrew those cities, and all the plain, and all the inhabitants of the cities, and that which grew upon the ground', with brimstone (sulphur) and fire raining from the skies. Also possible is that fault movements may have released petroleum and sulphurous gases from fissures, which then ignited – either spontaneously by lightning or by seismic activity – thereby explaining the

TOP In Classical Greece, Poseidon, god of the sea, was usually considered to be responsible for earthquakes – although Greek thinkers, among them Aristotle, preferred to seek out natural explanations. **RIGHT** Earthquakes and the Bible: the *Crucifixion* by Il Pordenone (1521) from the cathedral of Cremona in Italy. Matthew's description of seismic activity at the moment of Christ's death may have been inspired by a real earthquake that shook Jerusalem in 31 BC.

biblical reference to brimstone and fire. Such ignition was observed in a petroleum seep from the flank of the San Gabriel Mountains, north of Los Angeles, during the Fort Tejon earthquake in 1857.

A second famous episode of urban destruction from the Old Testament, Joshua's capture of Jericho with his army's trumpet blast, traditionally dated between 1400 and 1250 BC by biblical historians, also lacks a specific reference to an earthquake. But if we put aside miracles, seismic intervention appears even more probable than at Sodom and Gomorrah. Archaeological excavation of Tel Jericho indicates as many as 22 levels of destruction and the repair or complete rebuilding of the city's walls no fewer than 16 times. Some of this destruction was almost certainly due to earthquakes, given that devastating earthquakes have undoubtedly occurred at or near Jericho in historical times. No single excavation level of Tel Jericho has been identified with Joshua's attack, nor is there a totally convincing explanation for the absence of an 'earthquake' in the biblical account. The most likely hypothesis is that a single earthquake dammed the River Jordan and at the same time demolished the walls of Jericho. Thus, 'Joshua would have arrived to find that the city had already been conquered for him, apparently by God,' suggests geophysicist Amos Nur. 'The embellishments of marching around the city seven times, the shout and the sound



of trumpets would all make the story more dramatic in the retelling as it was passed down through the years.'

Collapse in the Med

A century or two later, around 1200 BC, came the collapse of the Bronze Age civilisations in the eastern Mediterranean. Here there are almost no literary sources like the Bible apart from a handful of cryptic inscriptions, only the archaeological evidence of destruction at 47 sites ranging from Knossos in Crete and Mycenae and Pylos in mainland Greece through Troy, Miletus, and Hattusas in Anatolia; Carchemish, Aleppo, and Ugarit in Syria; Megiddo (Armageddon), Lachish, and Ashkelon in the Levant; to four less famous sites on Cyprus, such as Enkomi.

Sceptical archaeologists ask: if earthquakes destroyed the cities, why were they not rebuilt? Reconstruction was the rule after other ancient (and modern) earthquakes, observes Classicist Robert Drews in *The End of the Bronze Age*. 'One is therefore reluctant to believe that *circa* 1200 BC a number of the most important places in the eastern Mediterranean were hit by a quake from which they could not recover.' For such earthquake sceptics, the preferred explanation of the Bronze Age collapse is maritime invasions by the Sea Peoples, whose existence is hinted at, but never properly defined, in ancient Egyptian chronicles. However, the identity of the



Sea Peoples and their lands of origin have for decades proved to be almost as elusive as the sea-god Poseidon.

The earthquake in about 464 BC that struck Sparta is one of the very few earthquakes of antiquity that was fairly reliably reported. Thucydides, writing his *History of the Peloponnesian War* in the same century, noted that the earthquake led to a revolt against Sparta by its subject peoples, the Helots of Laconia and Messenia. A later Greek historian, Diodorus Siculus, agreed, calling the earthquake 'a great and incredible catastrophe'. Today, a fault scarp 10-12 metres high and about 20 kilometres in length passes within only a few kilometres of the site of ancient Sparta. Diodorus claims that more than 20,000 Spartan citizens died in the earthquake as a result of the 'tumbling down of the city and the falling of the houses' over a long period. Such a high number of Spartan casualties is probably an exaggeration. Nevertheless, the Spartans were in due course obliged to recruit non-citizens as hoplites for their army, who did not fully subscribe to the famously disciplined Spartan military code. Without doubt, the earthquake was a factor in the origin of the Peloponnesian wars between Sparta and Athens, which began in 460 BC and lasted until the end of the 5th century. For when the subject peoples saw that a majority of the Spartans had perished, 'they held in contempt the survivors, who were few', writes Diodorus. The Helots took the opportunity of the earthquake to rebel against the Spartans, who requested help from the Athenians,

who in response sent a force of Athenian hoplites to Sparta. The Athenians, however, were shocked to discover that the rebels against Sparta were Greeks like themselves. The Spartans, fearing that the Athenian soldiers would make common cause with the Helots, found a pretext to send the Athenians packing, thereby permanently souring Sparta's relationship with Athens.

BELOW General view across the ruins of Tel Jericho: the site of the ancient city. The Old Testament's Joshua is said to have captured the city with his army's trumpet blast – as shown inset – but is this account really the memory of an earthquake? Certainly, excavations at the site have shown 16 episodes of rebuilding to the city's walls. **RIGHT** Wood engraving from the illustrated Bible by Gustave Doré of the destruction of the walls of Jericho (1866).



EARTH-SHATTERING EVENTS

LEFT The Lord's destruction of the sinful cities of Sodom and Gomorrah is hellishly depicted by Joachim Patinir (d. 1524). Judging from the event's biblical description, it may have involved an earthquake, at least in part.

By an odd coincidence, the date of the earliest reported earthquake in ancient Rome is almost the same as that in ancient Greece. In 461 BC, according to Livy, writing in the final decades of the 1st century BC, 'The ground was shaken by a violent earthquake.' Another, in 83 BC, damaged Rome's public buildings and houses, and was treated as an omen of civil war. Two earthquakes in AD 443 and 484 damaged the Colosseum, as is clear from a tablet near the entrance to the building thanking Decius Marius Venantius Basilius for his generosity in subsidising its repair; and another major earthquake in 1349 most likely damaged the Colosseum beyond repair. ▶

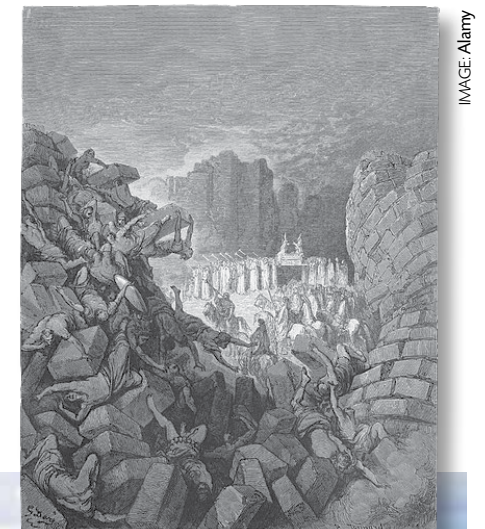


IMAGE: Alamy



LEFT Miletus (far left) and Mycenae (left): did earthquakes around 1200 BC lead to the collapse of these cities?

earthquakes. Petra, a centre of the spice trade with China, Egypt, Greece, and India, was the capital of the Nabataeans, who ruled the surrounding region from the early 3rd century BC, after the time of Alexander, until AD 106. Most of its celebrated buildings date from the Nabataean period. Analysis of their ruins, especially the fallen columns, suggests that they collapsed in a major earthquake. This probably occurred in AD 363 – the date of an earthquake known to have damaged neighbouring Jerusalem – according to the evidence of coins discovered in a belt-purse belonging to a crushed female skeleton in one of the city's Roman houses: the coins were minted after a Roman currency reform in 354. But it is far from clear how this 363 earthquake affected the habitability of Petra.

China & Japan respond

By the time of Petra's decline, China had embarked on the earliest attempt to measure earthquakes, setting the tone for the country's unique relationship with seismicity. Although the Chinese have long suffered from major earthquakes, including some of the most deadly in world history, they did not develop any earthquake mythology – in striking contrast to the Japanese. From the beginning, the Chinese intelligentsia took a practical attitude towards earthquakes, seeing them as fundamentally natural, not divine, phenomena. China boasts not only the oldest record of an earthquake (780 BC), but also the oldest instrument to measure an earthquake, invented in AD 132 by a

an earthquake. The city was rebuilt; but another earthquake in 526, followed by a year and a half of aftershocks, culminating in a second earthquake in 528, proved catastrophic. About 250,000 people were killed in the 526 earthquake and fire, and the octagonal Great Church, built by the Roman emperor Constantine after his conversion to Christianity, was destroyed. In Constantinople, the Byzantine (East Roman) emperor, Justin I, publicly lamented the ruination of Antioch. But he and his successor, Justinian the Great, nevertheless strove to rebuild both the church and the city. In the end, it was not the earthquakes of the 520s that led to the abandonment of Antioch. Faction-fighting and rioting (centred on the chariot races at the circus), religious strife, the outbreak of bubonic plague, and the sacking of the city by the Persians in 540, 573, and 610, together ended its glory. By the time of Antioch's capture by Arab forces in 637, the city had been reduced to little more than a frontier fortress, which the Arabs renamed Antakya.

The abandonment, possibly around the same time, of another famous Near Eastern city, 'rose-red' Petra, in Jordan, also appears to have involved a massive earthquake or

Pummelling the empire

That said, no earthquake in Rome – unlike in Sparta – was ever severe enough to shake the stability of the Roman state. Other parts of Italy suffered from much greater shaking than the capital city, as they do today. In AD 64, for example, an earthquake rocked Naples while the Emperor Nero was performing in the main theatre. Indeed, just before this shaking, Pompeii and Herculaneum had come through a severe earthquake. Against Nero's advice to abandon Pompeii, much of the city was rebuilt in the AD 60s and 70s, initially without financial help from Rome. The excavated house of a banker contains a substantial memorial to the earthquake: a shrine with two marble reliefs on either side. One sculpted scene shows the temple of Jupiter in the forum and a neighbouring building dramatically tilting over towards the left, next to an upright scene of animal sacrifice by a priestess (presumably performed after the earthquake). Many buildings of the forum of Pompeii were fully repaired and newly decorated by the time of the eruption of Vesuvius in 79.

Compared with the Italian peninsula, the Roman empire in the east experienced greater earthquakes, especially in Turkey. For example, Antioch's first recorded earthquake was in 148 BC, followed by another in 130 BC. In AD 115 – when the Roman empire reached its greatest extent – there was a severe earthquake in Antioch. Many died, including one of the consuls, during a visit by the Roman emperor Trajan, who was injured and spent the rest of his visit living in the open in the circus. In 458, nearly all of the buildings in Antioch were destroyed by

RIGHT The Colosseum in Rome was damaged by two earthquakes in AD 443 and 484. The tablet (**INSET**) near the entrance to the building acknowledges funds given for its repair. However, another major earthquake in 1349 most likely damaged it beyond repair.



IMAGES: Dreamstime



EARTH-SHATTERING EVENTS

LEFT Earthquake in Pompeii in AD 62 or 63, as depicted in a relief from the house of banker Lucius Caecilius Iucundus. It shows the Vesuvius Gate, a collapsing water tower, and an escaping chariot.

Chinese astronomer and mathematician at the imperial court, Zhang Heng.

According to a Chinese history, *Gokanjo* ('History of the Later Han'), in AD 138 Zhang Heng's seismometer is said to have enabled him to announce the occurrence of a major earthquake at Rosei, 650 kilometres to the north-west of the Chinese capital, Loyang, two or three days before news of the devastation arrived via messengers on galloping horses. The imperial government now appointed a secretary to monitor the behaviour of the seismometer, which remained in existence for four centuries. This scientific Chinese attitude to earthquakes seems to have carried over into effective official disaster response. Unlike some other natural disasters, such as floods, great earthquakes never threatened the existence of an imperial Chinese government over two or three millennia. This was true even after an earthquake in 1556, during the Ming dynasty, claimed up to 830,000 lives in Shaanxi province and nine neighbouring provinces: a world record for fatalities in a single earthquake.

Japan's earthquakes have had more effect on Japanese history than China's have on Chinese history, despite costing fewer lives – probably because of Japan's far smaller area. The earliest reliable Japanese earthquake report (AD 599) occurs in the *Nihon Shoki* chronicle, compiled in AD 720. But the earliest

actual listing of Japanese earthquakes is only a little more than a millennium old. Dated AD 900, it documents 700 earthquakes before AD 887. As for earthquake archaeology in Japan, unlike in Europe and the Middle East, it is severely constrained by the fact that old Japanese buildings have rarely survived in the archaeological record because of their perishable methods of construction, based on a pounded-earth foundation platform with wattle-and-daub walls and wooden load-bearing posts for the roof. Bricks, whether fired or unfired, were not used in Japan until the 19th century.

During this traditional period, the most serious earthquakes to ravage Edo (Tokyo) were those of 1703 and 1855. The second provoked the popular outpouring of catfish prints (*namazu-e*), and was influential in the ending of the late Tokugawa shogunate and the opening of Japan to American and European influence. After 1868, Japan's modernising movement eagerly embraced Western science and expatriate Western scientists, including the emerging discipline of seismology. Within a few decades, the Japanese had evolved a vigorous, indigenous school of seismology. By the time of the Great Kanto earthquake in Tokyo in 1923, and the invention in California of the Richter magnitude scale soon after, the earthquake mythology of the *namazu* was no longer relevant.

Even so, the *namazu* remains the symbol of the world's most sophisticated earthquake warning system. Today, seismologists may be able to monitor the vibration of the planet second by second, and the movement of tectonic plates millimetre by millimetre, yet great earthquakes are still essentially 'acts of God', striking with much less warning than volcanoes, floods, hurricanes, and even tornadoes and tsunamis. Shockingly, in the 21st century we are no more successful in predicting the location and timing of great earthquakes than were the natural philosophers of ancient Greece, Rome, and China. ■

BELOW In AD 132, Chinese astronomer Zhang Heng invented the first seismometer: an earthquake caused a ball to fall from a dragon's mouth into the mouth of one of the toads located at the points of the compass. This later version probably resembles the original, but its internal mechanism is unknown.



BELOW These columns at Petra in Jordan may have fallen in an earthquake.



FURTHER READING

Earth-Shattering Events: Earthquakes, Nations and Civilization, by Andrew Robinson, was published by Thames & Hudson in April 2016, £18.95. www.andrew-robinson.org

