# THE BUILDINGS THAT REVOLUTIONIZED ARCHITECTURE

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FLORIAN HEINE AND ISABEL KUHL

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# FOREWORD

**Architecture is often referred to as the 'mother of all art' in that it brings together the other arts under its roof. This may well be the case, but architecture is different in that it must also meet very functional and practical demands that do not apply to the other arts. Jacques Herzog, who collaborated on the construction of the Beijing National Stadium, had the following to say in 2004 on the subject of art and architecture: 'Architecture is architecture, and art is art. Architecture as art is unbearable.'**

In keeping with this dictum, the 100 works of architecture introduced here are pure architecture, though they do also meet the highest artistic standards. Covering four millennia, located all over the globe and shaped by a wide variety of influences, they form an overview of how architecture has developed over time. Architecture has always had the same fundamental importance throughout the course of history, and has played a similar role across all the continents.

Everyday 'functional architecture' is only of minor significance in the 'art history' of architecture, and is only rarely discussed. The history of architecture is generally concerned with the high-profile projects that, over the centuries, have often been constructed to great acclaim, combining considerable artistic and financial effort. These include temples, churches, residences and, more recently, factories and museums, to name a few examples. Yet architecture has often had – and continues to have – a greater influence on its environment, and even on history, than its protagonists may realise at the time. St Peter's in Rome, for example, was a catalyst for the Reformation in the same way the Great Wall of China was responsible for the end of the Ming dynasty. A more recent example is the Guggenheim Museum in Bilbao and the tremendously positive effect it has always had on the economy of the entire region.

Architects are always also innovators, who constantly come up with new possibilities, techniques and materials with which to execute their ideas. Examples include the master builders of the Gothic period: Filippo Brunelleschi when he constructed the dome for the cathedral in Florence, Thomas Pritchard, who built the first iron bridge, Walter Gropius, whose small-scale Fagus factory fired the starting shot for great innovation, and Shigeru Ban, who discovered that cardboard could be used for architecture. The importance of the relationship between the person commissioning the work and the architect should not be underestimated, however. Rulers, church dignitaries and the bosses of companies have often shown great foresight and courage in their decisions to commission one particular architect or another. The fact that part of their motivation is often rooted in the desire to demonstrate power and influence, for which architects have developed a language, is probably inevitable. As Shigeru Ban has said, 'We are supposed to make power and money visible through monumental architecture.'

Whatever the motives for individual commissions may have been, master builders, engineers and architects have continuously developed architecture over the course of the centuries. The 100 works of architecture presented in this book provide an overview of that development throughout the world. It is, sadly, not possible for a book to do justice to the character and effect of a building in just a few photographs. The aim of *The Buildings That Revolutionized Architecture* is therefore also to serve as an inspiration and invitation to visit one or other of the buildings in person in order to fully experience the diversity of architecture at close range.

Florian Heine

'THIS SYMMETRICAL PYRAMID OF CHEOPS – THIS SOLID MOUNTAIN OF STONE REARED BY THE PATIENT HANDS OF MEN – THIS MIGHTY TOMB OF A FORGOTTEN MONARCH ...'

Mark Twain

**THE PYRAMIDS OF GIZA,** CIRCA 2620–2500 BC

# 1
# PYRAMIDS OF GIZA

**Mark Twain's memory of climbing the Great Pyramid of Cheops was not a pleasant one. The effect of the gigantic structure on the west bank of the Nile changed as the traveller approached it. The 'fairy vision' that he had seen from afar eventually became 'a corrugated, unsightly mountain of stone'.**

No doubt the tiring ascent greatly contributed to this damning judgement, as the largest architectural structure of the ancient world must have been impressive even in its guise as a mountain of stone: the most imposing of the Egyptian pyramids, the burial site of Pharaoh Cheops is the last of the Seven Wonders of the Ancient World still in existence. It was built around the middle of the third millennium BC in Giza, just a few kilometres south-west of Cairo. To date, more than 80 pyramids have been discovered along the Nile valley, an entire city of the dead that is visible from afar in the flat landscape on the edge of the Libyan Desert. Although Cheops commissioned the biggest of the royal burial sites, the neighbouring pyramids of his son Chephren and of Chephren's son Mykerinos are only marginally smaller. The queens were buried in three smaller pyramids, and they are surrounded by hundreds of other graves and temples, making the pyramid fields an enormous graveyard.
Thousands of labourers worked for almost 30 years on the construction of the first pyramid alone, the burial site of Cheops. They layered an unimaginable 2.5 million stones on top of one another. Thousands of stonemasons were in charge of supplying blocks of limestone, basalt and granite from quarries. The total weight of the Great Pyramid of Cheops is estimated at more than six million tonnes. If one counts servants and haulers, between 20,000 and 25,000 people – approximately one per cent of the total population of Egypt – are thought to have been employed in the construction of the Great Pyramid of Cheops. The architects included experts in mathematics, who appear to have had no trouble calculating the precise volumes and right angles. Starting from a square ground plan, the pyramids rise as triangles that intersect at the tip. The smooth surfaces converge without a step despite the fact that the edges measure more than 230 metres. The entrance to the pyramid lay in the north, from which a low passageway sloped downwards. The burial chamber constitutes the centre of the body of the building, in which the stone sarcophagus containing the embalmed body of the pharaoh was laid to rest. The Egyptians were convinced that the dead pharaoh lived for all eternity in his pyramid, so that it was essential to supply and protect him for all eternity. Heavy stones protected the burial chamber from intruders in search of precious burial furnishings, and the circulation of fresh air was ensured. Despite all precautions, the burial chamber was looted, possibly even during the age of the pharaohs. Its reputation as a Wonder of the World remains undiminished, however.

# 2
# GREAT TEMPLE, ABU SIMBEL

**It must have been an astonishing sight when Jean Louis Burckhardt (1784–1817) saw the great stone head of Ramesses II jutting out of a sand dune in 1813. Shortly beforehand, the Swiss explorer of the Orient had been the first European to see Petra, a city hewn from rock. He cannot have guessed what he had just discovered on the border to Sudan: the temples of Pharaoh Ramesses II (circa 1303–1213 BC) and his principal wife, Nefertari, which were built on the occasion of the 30th anniversary of his accession to the throne.**

The pharaoh's great temple was cut 63 metres into the rock between 1290 and 1260 BC. Two pairs of colossal seated statues representing the deified pharaoh (each measuring 22 metres in height) can be seen along the façade, which is 33 metres high and 35 metres wide. A hypostyle hall, eight metres in height and painted in colour, features statues and reliefs depicting military scenes of the conquest of Nubia. It is followed by a chamber that represents the holy centre of the temple. Here, Ramesses is represented in the midst of the divine trinity. Burckhardt saw none of this because the excavations did not begin until 1817, under the Italian Giovanni Battista Belzoni (1778–1823), and were not (for the most part) completed until 1909. Early photographs from circa 1850 show the enormous stone heads still deeply buried in the sand.

Even before Ramesses II ordered the temple to be built, this was the site of two sacred grottoes dedicated to the local gods of the vanquished Nubians. The construction of the temples must therefore also be understood as a symbol of the worldly and religious submission of the Nubians to the Egyptian kingdom: as a symbol of power. They were also an 'offshoot' of the main royal palace in Thebes.

The temple complex gained particular fame and importance – in addition to its significance as evidence of the former vastness of the Egyptian kingdom – when the Aswan Dam was planned and the temple complex threatened to be submerged in Lake Nasser. This gave rise to the extraordinary idea of moving the temples. An international consortium was founded and what must have been the most unusual archaeological task of its time began in November 1963. First the structures were hardened using 33 tonnes of epoxy resin, and then they were sawn into 1,036 blocks weighing between seven and 30 tonnes each. The temples were dismantled bit by bit, and reassembled 180 metres to the north-west and 65 metres higher up. Particular attention was paid to the temple's precise alignment with the sun because the sun illuminates the innermost section of the Great Temple on the spring and autumn equinox.

As these particular temples are hewn into the rock, the rock, too, had to be moved. The interior of the Great Temple is supported by a steel dome 140 metres high. It is no longer visible for it has been covered by sand, stones and 1,112 pieces of rock from the original surroundings. The procedure was not completed until September 1968. The project, which cost some 80 million US dollars and was financed by more than 50 states, was one of the main reasons for the foundation of the UNESCO World Heritage Convention of 1972 and the establishment of the World Cultural Heritage List. The temple complex of Abu Simbel is evidence of both the brilliance of the ancient Egyptians and the engineering skill of the 20th century. It also shows what can be achieved by a united world community to preserve the world's heritage. The temple complex itself was not included in the list until 1979.

'OH YE LABOURERS, SELECTED, STRONG, DILIGENT OF HAND, WHO ERECT ALL NUMBER OF MONUMENTS FOR ME, EXPERIENCED AT WORKING WITH PRECIOUS STONES, RECOGNISING TYPES OF GRANITE AND FAMILIAR WITH SANDSTONE. OH YE DILIGENT AND INDUSTRIOUS BUILDERS OF MONUMENTS! I SHALL LIVE AS LONG AS THEY!'

Homage of Ramesses II to his workers

**THE GREAT TEMPLE, ABU SIMBEL,** 1290–1260 BC

# 3
# THE GREAT WALL OF CHINA

**The Great Wall of China is not one, unified structure but the sum of many parts built over the course of two thousand years. Until recently, estimates of its length had ranged from 4,000 to 6,500 kilometres and beyond. The wall features approximately 25,000 towers, and its hundreds of elements are spread out across China. Impressive as these numbers are, the wall cannot in fact be seen from space with the naked eye.**

The Chinese name for the Great Wall is 'The Long Wall of 10,000 Li'. With one *li* equal to 575.5 metres, this corresponds to an overall length of 5,755 kilometres, which comes close to several estimates. In Chinese, however, the figure 10,000 has the additional meaning of 'an infinite number' or 'unimaginably long', both of which are suitable descriptions of the wall. The part that is often referred to as the Great Wall was constructed during the Ming dynasty (1368 to 1644), whereas the oldest section appears to have been built as long ago as 214 BC by the first emperor of China, Qin Shihuangdi, as protection against the peoples of the north. Some researchers believe that construction began as far back as the 7th century BC. These very old sections of the wall are more like mounds of earth that were shored up with clay and natural stone. The wall was continually expanded over the centuries. The section of wall dating to the Ming dynasty was built starting in 1493, or 1555 at the latest. Its aim was both to provide protection against the Mongols and to control trade. It extends from the west part, the Jade Gate, over mountains, rivers and lakes, and ends in the east at the Dragon's Head, jutting out into the sea at Shanhaiguan. Only about a twelfth of the wall – some 500 kilometres of the 6,000 kilometres or so that make up the wall are well preserved, however. The rest has fallen into disrepair or was dismantled for building materials over the course of centuries. During its extended construction period the wall was built to a thickness of six to ten metres and up to 16 metres in height. One of the 25,000 towers was erected every couple of hundred metres. They were effective both as fortifications and for signalling.

In 2012 China published the results of a new archaeological survey of the Great Wall and declared it to be considerably longer than previously thought, extending 21,196.18 kilometres across 15 provinces. The measuring, involving two thousand researchers and technicians, had taken four years to complete. How long the wall really is, and which of its many sections should be included in the measurements, is obviously a matter of opinion. But this is not the most important issue. The wall is clearly the world's largest man-made structure, and its history ended in 1644 with the fall of the Ming dynasty, ushered in by the Manchu conquest of China in the east. Originally built to ward off invasion, the wall had in fact long been a symbol of an isolationist view of the world with which China, certain of its own greatness, rejected engagement with the rest of the world.

For the Chinese themselves, the Great Wall did not begin to regain significance until after Mao's Cultural Revolution (1966–76), when it came to be seen as an ideal symbol of national identity – and continues to be so regarded.

'A WALL FOUR HUNDRED MILES LONG WAS ERECTED BY THE KING BETWEEN THE MOUNTAIN CRESTS TO DEFEND AGAINST THE INVASIONS OF THE TATARS IN THIS REGION.'

From Abraham Ortelius, *Atlas Theatrum Orbis Terrarum*, 1584, including the first Western map of China

**THE GREAT WALL OF CHINA,** BEGUN IN 214 BC

'THE PARTHENON ... WAS ONE OF THE MOST GRACEFUL AND BEAUTIFUL EDIFICES EVER ERECTED.'

Mark Twain

**THE PARTHENON, ATHENS,** DEDICATED IN 438 BC

# 4

# PARTHENON, ATHENS

**It took five tonnes of silver to build the central temple on the Acropolis. The powerful city of Athens erected a magnificent monument to its patron goddess: a vast temple of white marble, decorated inside and out with sculptures, was created within the space of just 15 years.**

During the 5th century BC, Athens developed into one of the largest city-states in ancient Greece. Under the leadership of Pericles the city prospered: it became an important trading centre that underlined its power through a large navy, and it transformed itself into a democracy. This golden age was also reflected in the city architecture. On the Acropolis, the 'Castle Hill', Pericles was instrumental in the rebuilding of the temples destroyed during the war against the Persians, especially the Parthenon. Work began in 447 BC under the architect Iktinos: a hall of monumental columns, each of them more than ten metres in height, was constructed on an area measuring about 30 metres by 70 metres. Eight columns stand on the east and west fronts, and 17 on each of the long sides. These proportions determine the entire building. A horizontal beam rests on the columns, supporting a triangular gable on each of the two fronts.

The imposing marble temple was dedicated to the tutelary goddess of the city, Athena. Her statue, ten metres tall, stood in the cella, the innermost sanctuary of the temple. Apart from the wooden core, the figure was primarily of gold – more than 1,000 kilograms all told – and ivory, and she was decorated with precious stones. These valuable materials also formed part of the city treasury of Athens as well as the treasury of the Attic Naval Alliance, which the Greeks had founded in order to repulse the Persians. Athens levied some 11 tonnes of silver every year from its allies.

In building the Parthenon, the city-state emphasised its political significance. The sculpture that formed part of the architecture was correspondingly elaborate: Pericles commissioned the sculptor Phidias, who was famous even during his own lifetime, to create the pictorial decoration of the temple. The reliefs and sculptures showed scenes from historical battles and sieges, processions and parades full of pomp. Until well into the 17th century the temple resisted the ravages of time, but then a Venetian cannonball hit the gunpowder magazine that was stored there and badly damaged the building. Only parts of the sculptural ornamentation have survived, and for a long time they have not been in their original location: in around 1800, the British ambassador Lord Elgin had large sections removed and sold them to a purchaser in London. The so-called Elgin Marbles can now be admired in the British Museum; the debate surrounding their return to Athens continues. Despite all the ravages, the Parthenon is one of the most famous monuments of ancient Greece.

**THE GREEK TEMPLES OF ANTIQUITY** usually stood on a base with a rectangular ground plan. Their core was an elongated inner space, the cella, which was surrounded by a columned arcade. In the cella stood the cult image – in the case of the Parthenon, a monumental statue of Athena. Heavy cross-beams lay on the tapered columns of this round peripteral temple: horizontal building elements like load-bearing beams, friezes and lintels. The aim was to arrive at a harmonious relationship between vertical and horizontal lines. Architectural ornaments, including sculptures and relief friezes, adorned the otherwise simple buildings; the temples and their sculptural decoration were often also painted.

'THE PEOPLE OF EPIDAURUS HAVE A THEATRE IN THE SANCTUARY
THAT IS, IN MY OPINION, PARTICULARLY WORTH SEEING.'

Pausanias

**THE THEATRE OF EPIDAURUS,** CIRCA 330 BC

# 5
# THEATRE OF EPIDAURUS

**Thus wrote the Greek traveller and geographer Pausanias (flourished circa AD 143–176) in his *Description of Greece*. And the theatre continues to be worth a visit because it is the most well preserved of classical Greek theatres.**

The theatre was, however, just one part of the sanctuary of Asclepius, which was built here, in the mythical birthplace of the god of healing, from the 4th century BC. Epidaurus was a centre of pilgrimage and healing, in other words, something like a sacred sanatorium comparable with Lourdes and Fatima. The Greek geographer and historian Strabo (circa 63 BC–circa AD 23) wrote in his *Geography*: 'This city, too, is important, in particular because of the fame of Asclepius, who is believed to cure all sorts of diseases and whose temple is always filled with the sick.' In addition to the temples and sanatorium areas, there was a stadium and a theatre. This is because Asclepius's art of healing included not only the right diet, baths, medicinal plants and surgery, but also drama. The tragedies – and probably also comedies – aimed to touch people and develop their sense of empathy in order to cleanse their souls.

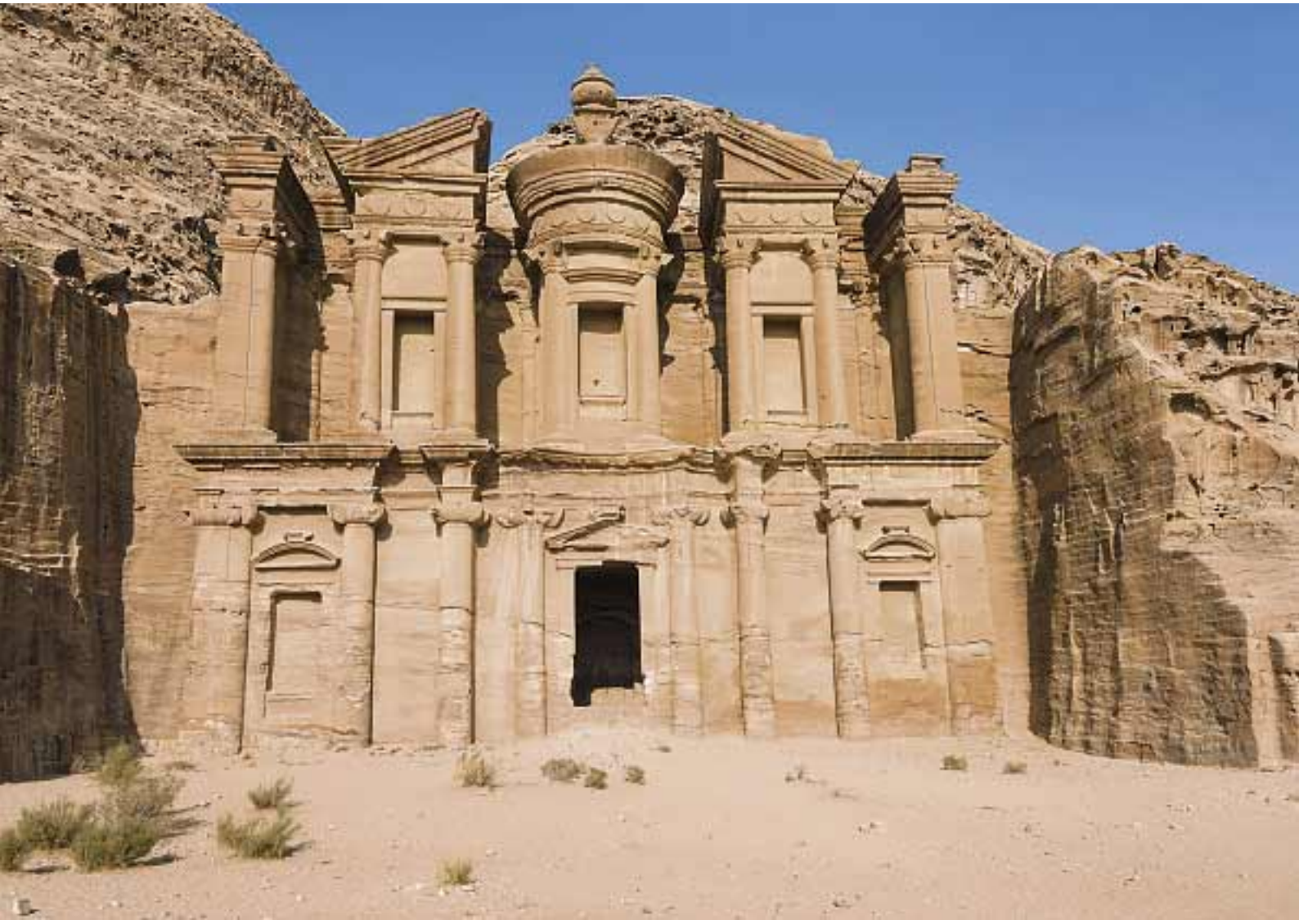
Most of the buildings of Epidaurus fell victim to the earthquakes of AD 522 and 551. Only the theatre has survived the passage of time and is the largest extant ancient Greek theatre. Pausanias names Polyclitus the Younger as the architect, though this remains unconfirmed. The theatre was built into a north-facing rock at Epidaurus in circa 330 BC, and had a capacity of 6,500 spectators. The 'theatron' (viewing area) consisted of 34 rows arranged around the circular 'orchestra' (performance area for the choir) in 12 wedge-shaped segments divided by the staircases. Only the outline of the 'skene' (two-storey stage building) and of the 'proskenion' remain today. The latter was the actual elevated performance area (measuring 22 by 2.17 metres) and it stood before a backdrop of a hall with 14 ionic half-columns. This could be used to stage 'special effects', including flying gods and the like, and various panels could be inserted between the columns as a stage set.

The theatre did not exist in its present state until the second phase of construction in the first half of the 2nd century. It seems audience numbers were so high that another 21 rows of seats were added. The theatre could now seat 14,000 people. This theatre is remarkable not only for its size, but also for its extraordinarily good acoustics. Even a whisper in the circular orchestra is clearly audible in the back row at the top, at a distance of approximately 60 metres. There are several reasons for this, including the arrangement of the seats: those built in the second construction phase in particular rise steeply and are concave. Secondly, it is clear that earthenware dishes were incorporated into the front rows as resonating bodies. Most importantly, perhaps, the surfaces of the rows of seats are not entirely smooth; they are rough, as is the case in modern recording studios. As a result, sounds have only short reverberations, which therefore do not overlap with their own echoes as they travel all the way to the back rows of seats.

The Asclepius sanctuary was destroyed by the Goths in AD 267, and later rebuilt. In AD 426 it was finally shut down by the Christian Emperor Theodosius II. Nowadays it is used as a performance space for classical theatre once again.

'IN THE RED SANDSTONE, OF WHICH THE ENTIRE VALLEY IS MADE, LIE ROUGHLY TWO HUNDRED AND FIFTY GRAVES, ENTIRELY HEWN FROM THE ROCK ... THESE INCLUDE A MAUSOLEUM IN THE SHAPE OF A TEMPLE, WHICH IS OF COLOSSAL DIMENSIONS AND THIS, TOO, IS HEWN FROM THE ROCK ...'

Jean Louis Burckhardt



**PETRA, JORDAN,** 1ST CENTURY BC (?)

# 6
# PETRA, JORDAN

**The 'treasury of the pharaoh' has the most famous façade in all of Petra, the ancient city carved from rock. The American director Steven Spielberg used it as a façade behind which Indiana Jones suspected the Holy Grail. Researchers, as well as film-makers, continue to be enraptured by the imposing structure of reddish sandstone.**

The Siq provides the only direct access to the ancient settlement in the desert of Jordan. More than one kilometre long, this narrow ravine between high cliffs leads to the city. Petra was an important base for the Nabataeans. The desert people established permanent settlements some two thousand years ago, and engaged in trade along the Incense Route in the north of the Arabian Peninsula. Petra was the junction of two roads through the desert, benefiting from the irrigation skills of the Nabataeans. A water conduit hewn into the rock kept the city supplied with water, which was stored in basins and tanks for the dry season. The natural fortress thus became an oasis in the desert, and its fortunes rose rapidly. Caravans stopped here, and the trading post between the cliffs became an economic and political centre. The upswing was accompanied by great building projects, all of which were realised using the local sandstone, which has a red sheen. The city's name means 'rock'.
The structures carved out of the rock include an entire theatre that accommodated around 8,000 spectators, as well as temples and shopping arcades along what was the main street. Since the ruins of the Nabataean city were discovered by the Swiss explorer of the Orient Jean Louis Burckhardt, archaeologists have examined only a small fragment of the area covered by the city. In the autumn of 1812 he wrote an enthusiastic letter about his journey to 'a place that […] no other European traveller has ever visited', and described the countless graves in the Greek and Egyptian style. The monumental scale of the burial structures, many of which are accessible via rock steps, is in itself impressive. Their façades frequently span two storeys, and they often feature columns and gables, parapets and arches, or they are embellished with rich sculptural details that have been carved out of the smooth surface of the rock. Some of the grave façades measuring several metres in height were even painted in a variety of colours. The most famous façade of the desert city lies on a big square surrounded by cliffs. The two-storey front of the 'treasury', which is thought also to have been a temple or a burial structure, rises to a height of almost 40 metres. The middle four of the six columns on the ground floor are surmounted by a pediment, and a pavilion-like circular structure is embedded between the sides of a broken pediment. Behind the magnificent façade lies a closed burial chamber that is thought to have housed stone sarcophagi. However, Indiana Jones remains the only archaeologist to date to have discovered the precise location of the door leading to the Guardians of the Holy Grail.

# 7
# COLOSSEUM, ROME

**Mark Twain called the Colosseum the 'monarch of all European ruins'. When the American writer visited the Roman amphitheatre, its history already spanned about 1,800 years. Although faded and crumbled, its monumental dimensions were impressive: in ancient Rome, the various tiers of seating accommodated as many as 70,000 spectators, who came to witness the battles between fearless gladiators and wild animals.**

The gigantic amphitheatre on the edge of the ancient city centre is the most famous architectural structure of the reign of Emperor Vespasian, who was nothing if not imaginative when it came to methods for collecting the funds necessary for his building projects. One day, while explaining his newest source of money to his son, he used the now famous expression 'Money does not stink!' – and promptly instituted a latrine tax. Thanks to innovative financial measures such as these, the Colosseum was built in record time: work began in the year AD 72 and was completed just eight years later. Built on an oval ground plan, the outermost ring of the amphitheatre is almost 50 metres high. And the arena itself covers an area measuring approximately 80 by 50 metres. The façade is decorated with rows of arches that vary from one storey to the next.

On the ground floor, 80 arches open onto steps inside. Four of the entrances on the main axes of the theatre were reserved for the exclusive use of high-ranking visitors. The common people entered the theatre through the remaining entrances. The four storeys of the building were divided into tiers and blocks, which the visitors accessed through a system of meticulously planned paths and entrances. Sophisticated logistical systems guaranteed that the spectacles ran smoothly, and yet access was free. The seating was rigidly regulated, however, with a strict separation according to origins, status and occupation. The first row behind the emperor's box, for example, was reserved for senators, and women had to make do with galleries located at the back.

The Colosseum remained an arena for popular spectacles until the 5th century: gladiatorial battles and animal hunts were regularly held for large audiences, and even sea battles were staged here, for which the enormous arena was flooded. Then Rome and its Colosseum fell silent. The building, which had in the meantime become a ruin, was forgotten until the Renaissance, when the popes needed building materials for their colossal architectural projects. The Colosseum certainly provided an abundant supply: approximately 100,000 cubic metres of travertine, as well as the marble used to cover the lower rows of seats, not to mention around 300 tonnes of iron, for the individual stone blocks were connected by metal pins, and these, too, were a building material popular with later generations. Despite its career as a quarry, and in defiance of earthquakes and fires, about two-fifths of the façade are still in place today. And what is left has impressed visitors to Rome since long before Mark Twain made his journey.

'EVERYBODY KNOWS THE PICTURE OF THE COLISEUM;
EVERYBODY RECOGNIZES AT ONCE THAT "LOOPED AND
WINDOWED" BANDBOX WITH A SIDE BITTEN OUT.'

Mark Twain

**THE COLOSSEUM, ROME,** AD 72–80