

Geological events in the bible

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ABSTRACT The books of the bible contain numerous, frequently very exact, descriptions of geological events. Some of these are discussed here: earthquakes and their accompanying landslides (the crossing of the River Jordan), seiches and tsunamis (the flood), flooding (Sodom and Gomorrah), faulting, burning gas seepages (the Burning Bush) and volcanism (Mount Sinai). These geological events appear in the biblical text mainly for artistic reasons; they serve as a suitable background to dramatize the biblical account; they create a supernatural atmosphere for the main stories, but the time and place at which they occurred are of no importance to the narrator and might be shifted freely.

Terra Nova, 1, 326–338

INTRODUCTION

Most studies of the bible deal either with its religious and moral message or its value as a source for historical events, or else with the history of the text. This paper deals with none of these aspects. Its subjects are the reasons for the depiction of geological events in the books of the bible and the use the biblical composers made of them.

The people who produced the bible lived through hundreds of years, both in the desert and the sown land, much closer to nature than any literate people today. Many of the geological events they witnessed must have impressed them deeply as, for the prescientific mind, these events were obviously supernatural in origin. It would be surprising if none of their impressions had found their way into their most important literary achievement. How and why this occurred is the subject of this paper; the spiritual and religious importance of the bible is not its concern. The number of geological features described or alluded to in the bible is very large; only a few, covering different areas of geology, are discussed in the following.

Biblical quotations are from the King James version, with the exception of translations from the book of Job, which are by the author.

EARTHQUAKES AND TSUNAMIS

Israel is situated astride the Dead Sea Rift, the boundary between the Arabian and African-Sinai Plates. This rift is produced by a leaking transform fault linking the Red Sea spreading centre to the line of continental collision extending from the Mediterranean to the Himalaya. The transverse extension along this line is taken up by the border faults of the rift, normal faults along which the floor of the rift has subsided, locally by at least 7 km – much of it during the Pleistocene. The longitudinal slip totalling about 105

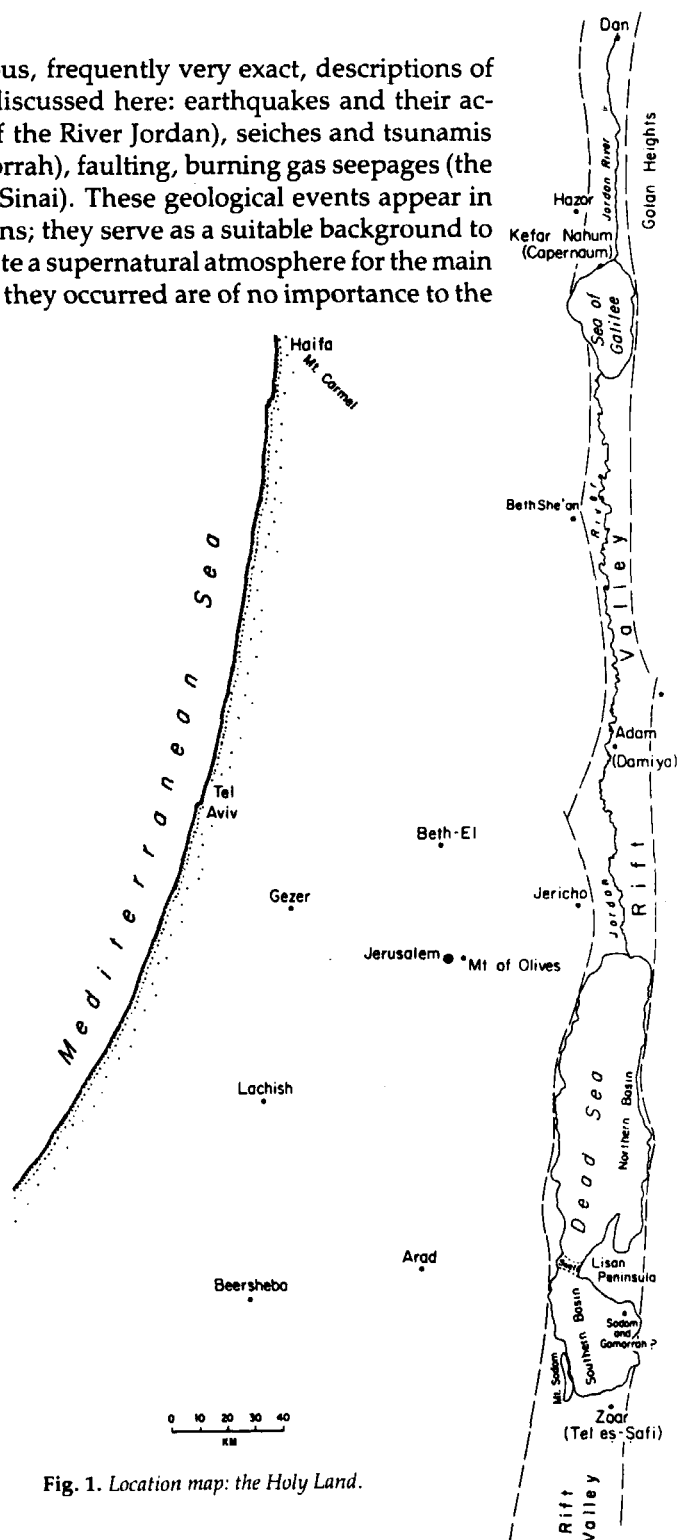


Fig. 1. Location map: the Holy Land.



Fig. 2. Columns at Hazor, tilted by Amos' earthquake about 760 BC; Area A, Stratum VI. From Yadin (1972).

km (Freund, 1965; Freund *et al.*, 1970) takes place along a zone of strike-slip faults, frequently arranged *en echelon*, at the bottom of the rift. Field evidence shows this zone to be still active with an average slip-rate during the Quaternary of about 1 cm yr^{-1} . During historical time, i.e. over the last 3000 years, about one large earthquake with a magnitude of 6.5 to 7 occurred per century along this transform fault in addition to several smaller ones (Ben-Menahem *et al.*, 1976; Garfunkel *et al.*, 1981; Reches and Hoexter, 1981). Thus, it is not surprising that destructive earthquakes or events related to them are mentioned repeatedly in the biblical record.

A good example is the first sentence in the book of the prophet Amos (1:1): 'The words of Amos . . . which he saw concerning Israel in the days of Uzziah, King of Judah . . . two years before the earthquake.' These words of Amos are supported by archaeological evidence. When the city of Hazor in Galilee was excavated (Fig. 1), level VI was dated to about the year 760 BC, the time Amos started his prophesies. The excavators found that the buildings of this stratum had partly been destroyed by a major earthquake. Walls of houses and pillars were tilted southward, and huge blocks of plaster had fallen from the ceilings (Fig. 2). This must have been a particularly violent earthquake, as it was used to mark the beginning of a new chronological era. The prophet Pseudo-Zechariah, living at the end of the fourth century BC, still mentioned it, 450 years after the event: 'Ye shall flee, like as ye fled before the earthquake in the days of Uzziah, King of Judah . . . ' (Zechariah 14:5).

Some 200 years later, in the middle of the sixth century BC, the author of the book of Job, a particularly keen observer of nature, described earthquakes in vivid language:

'Who displaces mountains and they know it not and overturns them in his anger; who makes the earth tremble from its place and breaks its pillars' (Job 9:5, 6).

The bible has another much more subtle story, behind which an even earlier earthquake is hidden – the story of the crossing of the River Jordan and the capture of Jericho (Fig. 1) by Joshua in the late 13th Century BC: 'And it came to pass, when the people removed from their tents, to pass over Jordan, and the priests bearing the ark of the covenant before the people, and as they that bore the ark were come unto Jordan, and the feet of the priests that bore the ark were dipped in the brine of the water (for Jordan overfloweth all his banks at the time of the harvest), that the waters that came down from above stood and rose up upon a heap very far at the city Adam, that is beside Zarethan: and those that came down toward the sea of the plain, even the salt sea, failed and were cut off: and the people passed over right against Jericho. And the priests that bore the ark of the covenant of the Lord stood firm on dry ground in the midst of Jordan, and all the Israelites passed over on dry ground, until all the people were passed clean over Jordan. . . . And it came to pass, when the priests that bore the ark of the covenant of the Lord were come up out of the midst of Jordan and the soles of the priests' feet were lifted up onto dry land, that the waters of Jordan returned onto their place, and flowed all over his banks as they did before.' (Joshua 3:14–17 and 4:18).

The clue to what happened, when the River Jordan stopped flowing, is the side-remark in the tale: the waters of the Jordan 'stood and rose up in a heap' not at Jericho itself, but much farther north, at Adam. This place, the modern Damiya, is 30 km north of Jericho; and there it happened again repeatedly. It is here that the river crosses the major strike-slip, the Jordan Valley Fault; its bed is very narrow

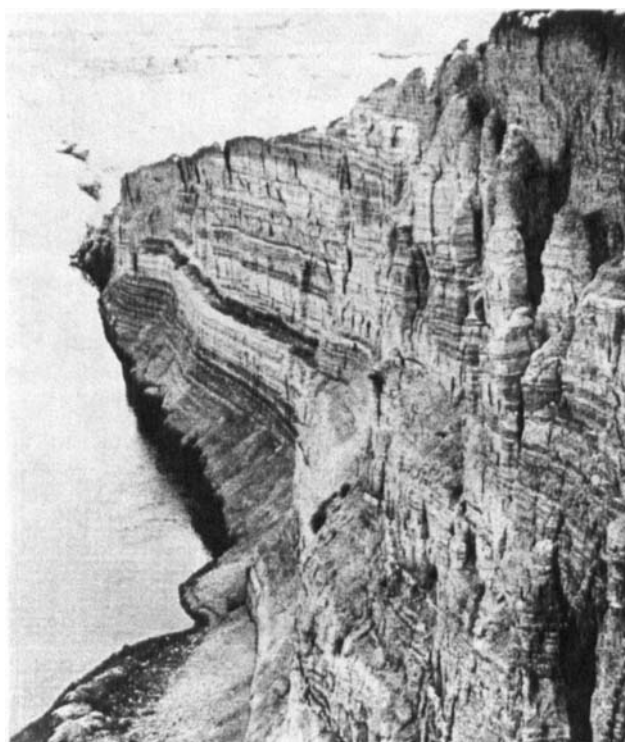


Fig. 4. (Above) A landslide of the bank of the River Jordan near Damiya which did not quite make it to the other bank. From Schattner(1962, fig. 20).

Fig. 3. (Left) River Jordan north of Damiya. From Schattner (1962, fig. 15).

here and deeply incised between almost vertical walls cut into the unconsolidated lacustrine chalks of the Late Pleistocene Lisan Formation (Figs 3 and 4). In the earthquake of 1546 AD the banks of the Jordan River caved in again at Damiya and the water of the river was cut off for two days (Braslavski, 1938); and it happened again at the same locality in 1267 (Watson, 1895), in 1906 (Ben-Menahem *et al.*, 1976) and most recently in 1927 when the strongest earthquake of this century so far, with a magnitude of 6.2, struck the country, and at Damiya the banks of the river caved in, forming a barrier and causing the stretch of the Jordan down-river to run dry. It took several hours for the water 'heaped up' above the barrier to break through and renew the flow.

Add to this account that the walls of Jericho (Fig. 5) came tumbling down to the sound of the trumpet and the shout of the people (Joshua, 6:20) shortly after Joshua and his people had crossed the river, and the connection with an earthquake seems inescapable.

According to the biblical tale the collapse of the walls of Jericho occurred three days after the earthquake. This could be an adjustment in the chronology to suit the story, but it could as well be that a strong aftershock took place which brought the walls, already weakened by the main shock, crashing down.

The link between the running dry of the Jordan River, followed by the destruction of the walls of Jericho, and an earthquake is not just the conclusion of a 20th century geologist; it was already recognized in antiquity. Here is what Psalm 114, 3-8 has to say about the event:

*'The sea saw it and fled,
Jordan was driven back.
The mountains skipped like rams,
The hills like little lambs.
What ailed thee, o thou sea, that you fleddest?
Thou Jordan that thou wast driven back?
Ye mountains that ye skipped like rams;
Ye hills, like little lambs?
Tremble, thou earth, at the presence of the Lord,
at the presence of the God of Jacob;
Which turned the rock into a standing water,
the flint into a fountain of waters.'*

Although couched in the poetic language of the psalms, it is evident that the connection between the earthquake and the interrupted flow of the River Jordan was understood already by the psalmist.

Another effect of earthquakes is vividly described in Amos, 9:6: 'He that calleth for the waters of the sea, and poureth them out upon the face of the earth: the Lord is his name.' These words clearly refer to tsunamis as do the first and fifth line of the forgoing quotation. Tsunamis are not infrequent in the Mediterranean with its many earthquakes and many of them start with a seaward retreat of the waters. The most important tsunami in the bible, however, might have occurred in another part of the Middle East, the Persian Gulf (Fig. 6). At the end of the nineteenth century (1885) Edward Suess argued that the story of the biblical flood might be based on an actual geological event. Tales of a flood that almost exterminated the human race were common in the

early Middle East and were probably first told in Sumer in the late fourth millennium BC. The country of the Sumerians was in Lower Mesopotamia on the only recently formed delta of the Tigris, Euphrates and Karun Rivers; the area was marshy, flat and low-lying, barely a few feet above the level of the Persian Gulf and was known by the inhabitants as the Sea Country. Almost all the old Sumerian cities – Eridu, Ur, Uruk (the biblical Erech), Larsa and others – were situated close to the northern shore of the Gulf. It can hardly be doubted that the Sumerian story of the flood, preserved as part of the later Gilgamesh epic, reflects an historical catastrophe; in fact, Sumerian sources divide the history of their cities into pre- and post-diluvial periods (Woolley, 1965). Edward Suess assumed that an earthquake took place in the Indian Ocean. This quake might have generated a tsunami wave which, in the narrow and shallow waters of the gulf, increased in height and destructive power as it rushed north and buried the Sumerian cities. This assumption has since gained support from the discovery by archaeologists that the oldest levels of many Sumerian cities are separated from the later ones by several metres of mud and sands (Jones, 1984).

The tsunami theory, first postulated by Suess, certainly points to one of several possible geological events which could have destroyed the country of Sumer. Recent studies of the effects of tsunamis have, however, cast some doubt

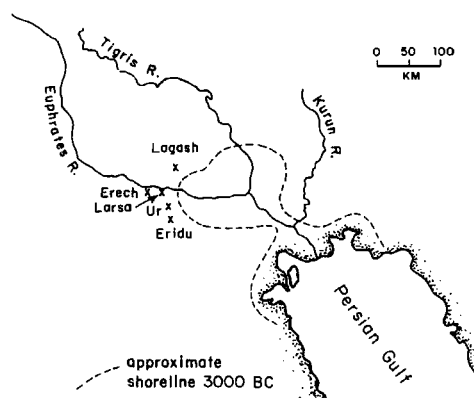


Fig. 6. Location map: The land of Sumer; modified from Woolley (1965).

on the assumption that a seismic wave of the required magnitude could have been generated in the Indian Ocean and reached the country of Sumer, after travelling through the relatively shallow waters of the Persian Gulf. Other geological mechanisms, such as a storm surge in the Gulf or a particularly strong flood of the rivers are equally possible. Whatever the cause, it is easy to imagine that the Sumerians regarded a catastrophe of that magnitude as the end of the whole human race, with the exception of Uta-Napishtim and his family, the Sumerian Noah.

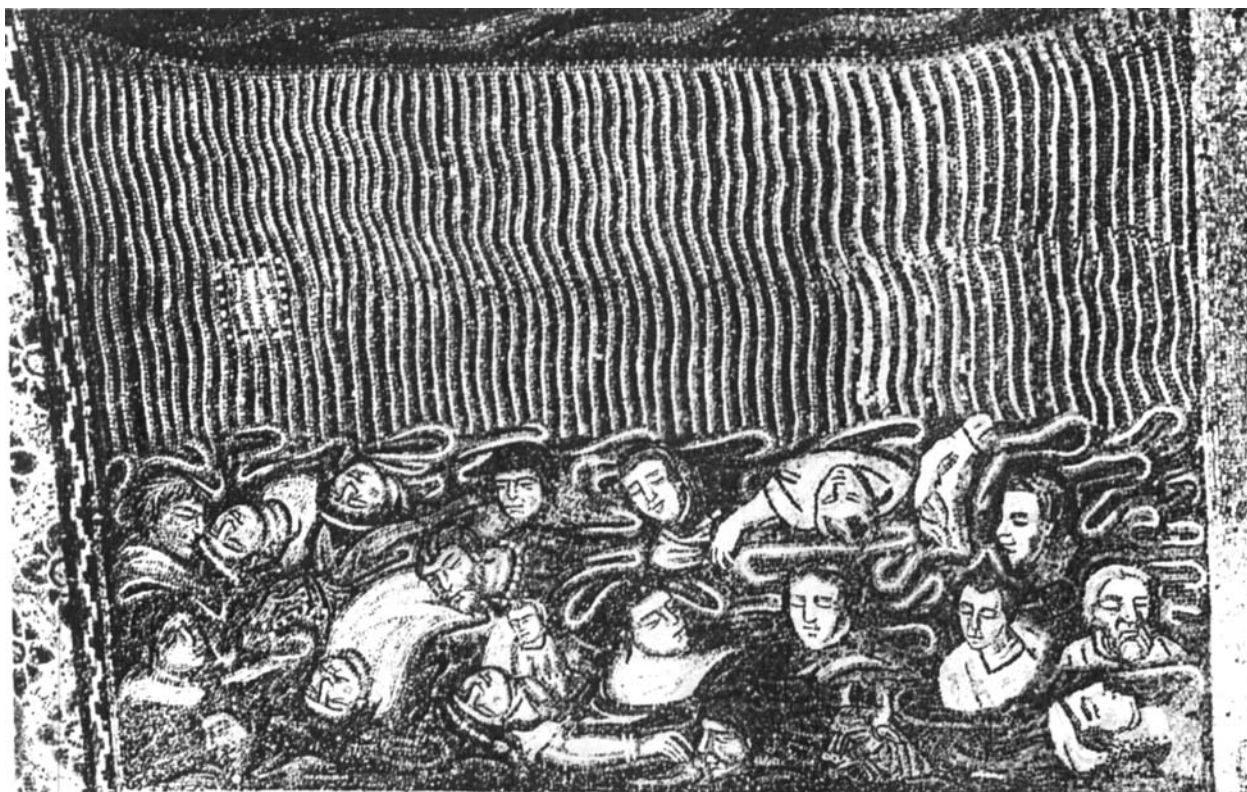


Fig. 7. The Flood; Mosaic, San Marco, Venezia, ~1220 AD. The rectangle in the rain represents the ark. Source: Fotografo Boehm.

Several thousand years later the bible took up the tale (Figs 7 and 8), transforming it into a moral warning of human wickedness and punishment.

SODOM AND GOMORRAH

One of the regions richest in geological stories in the biblical record is the area of the Dead Sea, the deepest part of the Dead Sea Rift. Along the base of the steep eastern fault scarp which rises about 1400 m above the level of the lake extends the still active Arava strike-slip fault. Close to the north-eastern corner of the lake this fault dies out and its left-lateral horizontal movement is taken over by the Jordan Valley Fault, lying some 8 km farther west and trending subparallel to the Arava Fault. Where a left-lateral strike fault is stepped to the left, a pull-apart rhomb-shaped graben will develop. Many of these are known along the length of the Dead Sea Rift but by far the largest is the deep rhomb-graben of the Dead Sea itself measuring about 100 km in length and 10 to 15 km in width. The pull-apart gap has been filled by a Miocene to Recent sedimentary, mainly clastic, fill, more than 7 km thick, at least half of which was deposited during the Quaternary. The Dead Sea area is thus one of the tectonically most active parts of the rift and the shores of the lake are the deepest point on the dry Earth, 400 m below Mediterranean sea-level.

Several of the stories connected with the Dead Sea go back some 5000 years. The area is first mentioned on the occasion of the quarrel between Abraham and his nephew Lot over grazing grounds for their herds. Abraham, the gentleman, said to Lot, *'Let their be no strife between me and thee and between my herdmen and thy herdmen, for we are brethren. Is not the whole land before thee? Separate thyself from me; if to the left hand, I will go to the right, if to the right hand, I will go to the left. And Lot lifted up his eyes and beheld all the Plain of Jordan, that it was well watered everywhere, before the Lord destroyed Sodom and Gomorrah, even as the garden of the Lord, like the land of Egypt as thou comest unto Zoar'* (Gen. 13:8–11).

Lot's choice was most surprising; with the entire land at his disposal, he chose what is now the driest, most desolate, most barren part, where nothing grows, as rain is rare and the soil abounds in accumulations of salt and gypsum. No cattle, sheep or goats can conceivably find grazing in this arid area today, and there is good evidence that some 5000 years ago the climate was not basically different from the present one. Why should Lot have preferred this hostile area to the well-watered Mediterranean coastal plain, the green Mount Carmel or the lush shores of the Sea of Galilee? Still, Lot might have had a valid reason for his choice, as will be shown later.

There is another peculiar feature concerning Sodom, where Lot settled, and neighbouring Gomorrah. Many of the cities mentioned in the biblical record have now been located: Dan, Hazor and Kfar Nahum (Capernaum), Beth-

Shean, Beth-El, Gezer, Lachish, Arad, Jericho (Fig. 1) and many others, but no trace of Sodom or Gomorrah has ever been found. It will be shown that this might well have a geological reason.

The same area is mentioned again in Genesis, Chapter 14 in the story of the battle of the King Kedar-Laomer, King of Elam and his confederates against the Kings of Sodom and Gomorrah and their allies. The battle took place *'in the Vale of Siddim'* (Gen. 14:3). Siddim means lime, a very apt geological name: the entire area surrounding the Dead Sea consists of soft, white, Late Pleistocene lake beds, the Lisan Formation, composed essentially of glaringly white aragonite crystals.

Not only the landscape, but also the action which took place here has geological connotations. This is what happened: *'And the Vale of Siddim was full of slime-pits; and as the Kings of Sodom and Gomorrah fled they fell into them, but they that remained fled to the mountain'* (Gen. 14:10). The term here translated as slime-pits occurs in other translations as lime-pits or clay-pits. All these translations are wrong; the original has *'be'eroth hemar'*, which mean asphalt wells (the translators confused *hemar* = asphalt with *homer* = clay). Even today the area is rich in asphalt seepages; temperatures in summer are very high here, 400 m below sea-level, and the surface rocks reach 70°C and more. Thus the Kings of Sodom and Gomorrah could well have been trapped in tar pits, the first victims of oil.

The most famous event in the history of Sodom and Gomorrah is, of course, their destruction because of the wickedness of their inhabitants; only Lot and his close family were destined to be saved. When the destruction was imminent and Lot, although warned, still hesitated to depart, angels dragged him and his family out of the city and said to him, *'Escape for thy life; look not behind thee, neither stay thou in all the pluin, escape to the mountain, lest thou be consumed'*. (Gen. 19:17). The tale then continues: *'The sun was risen upon the earth when Lot entered into Zoar. Then the Lord rained upon Sodom and Gomorrah brimstone and fire from the Lord out of heaven; and he overthrew those cities, and all the plain, and all the inhabitants of the cities, and that which grew upon the ground. But his wife looked back from behind him and she became a pillar of salt'* (Gen. 19:23–26). What happened next is told in Gen. 19:30: *'And Lot went up out of Zoar and dwelt in the mountain and his two daughters with him; for he feared to dwell in Zoar: and he dwelt in a cave, he and his two daughters.'*

The destruction of the two cities must have impressed the people tremendously. Over hundreds of years the disaster was remembered, and many biblical authors and others too wrote about it. Almost 2000 years after the event, Luke could pronounce the terse words: *'Remember Lot's wife'* (Luke 17:32) and be understood by all.

The story of Lot's wife is easiest to understand. It belongs to the type of myths created to explain unusual features of landscape or customs. At the south-western shore of the Dead Sea, opposite the presumed location of Sodom



Fig. 9. The column at the centre is identified as Lot's wife. Crest of Mount Sodom, a diapiric salt ridge at the south-western corner of the Dead Sea. The plain near the summit, sloping gently to the left, separates halite below from gypseous cap rock above.

and Gomorrah (see below), rises the diapiric salt-ridge of Mount Sodom. The cap-rock at the top of the salt mass is dissected by the rare rains into bizarre erosional remnants, one of which is still presented to tourists as Lot's wife turned into salt (Fig. 9). The fact that it consists largely of anhydrite overlying the salt is of minor importance.

The central problem in the whole story is obviously the way the two cities were destroyed. Could this be a case of geomythology, so frequent in the biblical narrative, in which an actual geological event was seized upon by a narrator to emphasize his specific purpose? Fortunately, in cases of this kind the biblical record has generally preserved in a half-sentence or an after-thought an echo of the original event, now largely buried by successive transmissions.

The critical words are the instructions of the angels which Lot followed after he had reached Zoar and the destruction of the cities had started. Lot was afraid to stay and left the city to climb the mountain. If the destruction had been the result of fire and brimstone from heaven, climbing a mountain to escape would be the last thing to do, particularly when the mountain slope is as high and as steep as at Zoar, where the mountain in question is nothing less than the almost vertical eastern fault scarp of the Dead Sea Rift. Lot could easily have put a much greater distance in a shorter time between himself and the scene of the disaster by running south along the gently rising floor of the rift valley. There is only one natural event in which the best way of escaping is to climb a mountain, and that is a flood. Would such an event be likely, given the circumstances of the case?

Until 1978, the Dead Sea consisted of two basins, a larger very deep one north of the Lisan Peninsula and a southern smaller, and very shallow one, south of it. The two were

separated by a sub-lacustrine swell, over which the water was only 1 to 2 metres deep. This swell is the surface expression of an underlying diapiric salt tongue protruding from the large, young and still active diapiric salt dome underlying most of the easterly adjoining Lisan Peninsula (Fig. 1). As about 95% of the water supply of the Dead Sea empties into the northern basin, very slight fluctuations in the level of the lake will cause the southern basin either to be dry or to be covered by water. In view of the geological structure of the Dead Sea area, a flooding of the swell holding up the waters of the northern basin is easily explained. There are at least three geological mechanisms, each of which could have caused such an event:

1. Climatically induced major fluctuations in the lake's level which are well attested (Klein, 1981, 1985) during historic and recent times.
2. The swell separating the two basins could have subsided by subsidence of the salt. This process occurs on a large scale, as is shown by Mount Sodom which lies at the south-western corner of the southern basin. This is a diapiric salt wall the summit of which has risen 200 m above the level of the plain and is rising still. The salt of this diapir is unconformably overlain by several tens of metres of an anhydritic cap-rock formed subrosively in contact with the regional groundwater level.
3. Seismic movements, so common in this area, could have caused a subsidence of the southern basin or a southward tilt of the entire rhomb-graben.

Whatever the cause, once the water started to spill over the dam, the latter would quickly have been eroded being built of unconsolidated lake chalk; this would have turned the spill into a flood which would have submerged the whole southern basin almost instantaneously.

There is ample evidence that changes of this type occurred repeatedly in historical time. The description in Joshua 15:2 of the southern boundary of the area allotted to the tribe of Judah shows that at the end of the 13th century BC, some 500 years after the destruction of Sodom and Gomorrah, the southern basin was part of the lake. Pliny the Elder visited at the Dead Sea in the first century AD and measured its size *in stadia*; we do not know the length of his stadia, but the ratio given by him of length to width of the lake fits closely the dimensions of the northern basin; thus, the southern part was dry at the time of his visit. It was still dry in Byzantine times, as seen in the mosaic in the church of Madaba (Fig. 10). This mosaic, composed about 560 AD, is a map showing the Dead Sea as seen from the city of Madaba, situated at the top of the eastern fault scarp, and in it the lake consists of the northern basin only. During most of modern time the southern basin was flooded. In 1977, however, the lake level had dropped so much that the southern basin was separated, started shrinking, and before our eyes dried out in less than 10 years.

Sodom and Gomorrah must have been located in the south-eastern part of the Dead Sea area, as is evident from the story of the partitioning of the land between Abraham and Lot (see above), as well as by the fact that Lot escaped to Zoar, which has been identified with Tel es Safi, a place at the south-eastern corner of the southern Dead Sea Basin. Let us assume that Sodom and Gomorrah were located somewhere on the east side within the southern basin, which was dry at that time. Such a location is strongly suggested by Genesis 14:3 in connection with the battle of the Kings. 'All these' (i.e. the kings) 'were joined together in the Vale of Siddim which is now the Salt Sea' (Salt Sea is the Hebrew name of the Dead Sea). As the battle could not have been fought under water, the southern basin must have been dry at that time, but flooded at the time the report was written down. Such a location of the cities would explain why their remains have never been discovered. Because of the very high sedimentation rate of the Dead Sea $50\text{--}100\text{ cm (1000 yr)}^{-1}$, the ruins would have been covered not only by the waters of the lake but also by several metres of sediments long before the beginning of modern archaeology.

Is there any corroborative evidence for the destruction of the cities by a flood? There are indeed a number of pieces of evidence:

1. The final remark in the bible on the destruction of the two cities is given in Gen. 19:27, 28: 'And Abraham got up early in the morning to the place where he stood before the Lord: and he looked toward Sodom and Gomorrah and toward all the land of the plain, and beheld, and lo, the smoke of the country went up as the smoke of a furnace.'

The crucial word in this sentence is the word smoke, and this again is an incorrect translation. The Hebrew term *kitor* does not signify smoke, but water vapour. Strong evaporation might indeed be expected as the waters of the northern basin broke the dam and flooded the hot rocks of the plain to the south.

2. Even more explicit is the Syrian Sanhuniaton, who lived in the first century BC and is quoted in Josephus (93 AD). In his work, *Phoenician History*, he gives the following description of the catastrophe: 'The Vale of Sidimus sank and became a lake, always evaporating and containing no fish, a symbol of vengeance and of death to the transgressor.'

Here then we have the older story of what actually happened, a version which was still very much alive in the memory of the local inhabitants when they told it to the Greek geographer Strabo who visited that area in the first century BC. This is what Strabo has to say of the event (Strabo, 23 AD, book XVI, 2.44): '... People believe the often repeated assertions of the local inhabitants' that the cities were destroyed when 'the lake burst its bounds and ... the cities were swallowed up and others were abandoned by such as were able to escape.' This was also the version which the pilgrim Theoderich (1986) gave when he visited the Holy Land in

1172, and it is shown again in the painting of Lucas van Leyden, painted in 1521 (see cover).

How then came fire and brimstone into the story? The tale of the destruction of the two cities is a good example of one of the ways in which the bible uses geological events. It seized upon the destruction of the cities to demonstrate the moral nature of human history. The editor of the account surely felt justified in replacing the flooding by the much more impressive mechanism of fire and brimstone raining down from heaven, the abode of God. This scenario may have been inspired by meteorite showers, mentioned repeatedly in the bible (e.g. Joshua 10:11). This pious embellishment was, however, not fully successful; too many hints of the original event remained embedded in the official account.

The destruction of the two cities by the breaking of the natural dam holding up the water of the northern Dead Sea Basin and the flooding of the southern one explains Lot's earlier decision to choose for his herds the area of the southern basin which was still dry at that time. Before the flooding freshwater springs probably issued there, creating a lush vegetation as now exists around the springs in the oasis of Jericho, at the northern edge of the Dead Sea. In fact, the bible itself says as much: 'And Lot ... beheld all the plain of Jordan, that it was well watered everywhere, before the Lord destroyed Sodom and Gomorrah' (Gen. 13:10). A few years after the present drying up of the southern basin freshwater seepages were found on the recently emerged lake bed.

STRIKE-SLIPS

In one of his visions the prophet Zechariah gives a particularly clear description of a geological phenomenon which was 'discovered' only about a hundred years ago. This is what he says: 'And his feet shall stand on that day upon the Mount of Olives, which is before Jerusalem on the east, and the Mount of Olives shall cleave in the midst thereof toward the east and toward the west and there shall be a very great valley; and half of the mountain shall remove toward the north and half of it toward the south' (Zech. 14:4).

This definition of a strike-slip fault, more than 2000 years old and the first we know of, could still be used in a glossary of geological terms.

It is immaterial to the argument that no strike-slip fault has ever been found on the Mount of Olives.

THE BURNING BUSH

The story of the Burning Bush is told in Exodus 3:2, 3: 'And the angel of the Lord appeared unto him' {Moses} 'in a flame of fire out of the midst of a bush: and he looked, and, behold, the bush burned with fire, and the bush was not consumed. And Moses said, I will now turn aside and see this great sight, why the bush is not burnt' (Fig. 12).

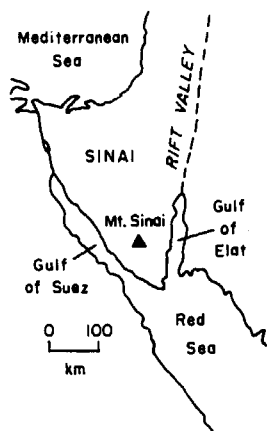


Fig. 13. Location map: Sinai.

Fig. 14. Moses receiving the Law. The mountain shows a volcanic flank eruption. Carolingian Miniature, Grandval Bible, ~840 AD, British Museum, London. Source: Bildarchiv Foto Marburg.



The crucial words in this story are: *'the bush burned with fire and the bush was not consumed.'* What could this mean?

The occasion was a very important one; it was the first meeting of Moses with God, who was about to confer on him the task of freeing the children of Israel from their bondage in Egypt and to lead them to the promised land. In giving his account, the narrator might well have looked for some, in his view, supernatural event which he could use to emphasize the importance of the occasion. He found it in an event which had happened long ago and far away, which he himself had probably never witnessed, but of which he had certainly heard. It should be remembered that Abraham, the first Hebrew, was born in Ur in Mesopotamia, a country rich in gas seepages which frequently caught fire. These burning gas seeps were regarded with awe; that any combustible matter, such as wood or coal, could burn and be turned into ashes was a common enough experience. But before Lavoisier, gases were not conceived as matter. Fire, not sustained by any perceptible matter, surely was a supernatural event; thus it became an important aspect of Sumerian religion (Kinnier Wilson, 1979) and, a thousand years after Abraham had left Ur, the inspiration for the Zoroastrian fire-worship in the old Persian religion of Ahura-Mazda, who appeared in fires and who was the god of one of the monotheistic, though dualistic, religions of antiquity. The story of the Burning Bush is thus an echo of events, the memory of which was brought by Abraham to the land of Israel to be transmitted orally from one generation to the next, over a long period of time. It might also be pointed out that the

Greek god Hephaistos and his Roman equivalent Vulcanus are derived from an Asian deity representing natural gas fires, not volcanic eruptions (Berger, pers. comm.).

VOLCANISM

It is a somewhat surprising fact that the biblical account of the giving of the law on Mount Sinai (Fig. 13) is closely interwoven with the description of a volcanic eruption. This is what the children of Israel saw when they were approaching still distant Mount Sinai: *'And the Lord went before them by day in a pillar of cloud, to lead them the way; and by night in a pillar of fire, to give them light; to go by day and night'* (Ex. 13:21). This is exactly what one sees when approaching an active volcano: a cloud of dark volcanic dust, gases and vapours which, at night takes on a red colour reflecting the light of the glowing lava.

When God was about to descend on Mount Sinai, this is what happened (Ex. 19:16,18; Ex. 20:18): *'And it came to pass on the third day in the morning, that there were thunders and lightnings and a thick cloud upon the mount, and the voice of the trumpet exceeding loud; so that all the people that was in the camp trembled. . . . And Mount Sinai was altogether on a smoke, because the Lord descended upon it in fire: and the smoke thereof ascended as the smoke of a furnace, and the whole mount quaked greatly. . . . And all the people saw the thunders, and the lightnings'* (literally: 'torches'), *'and the noise of the trumpet, and the mountain smoking; and when the people saw it, they removed and stood afar off.'* Deuteronomy 4:11 adds two more elements: *'And ye came near and stood under the mountain; and*

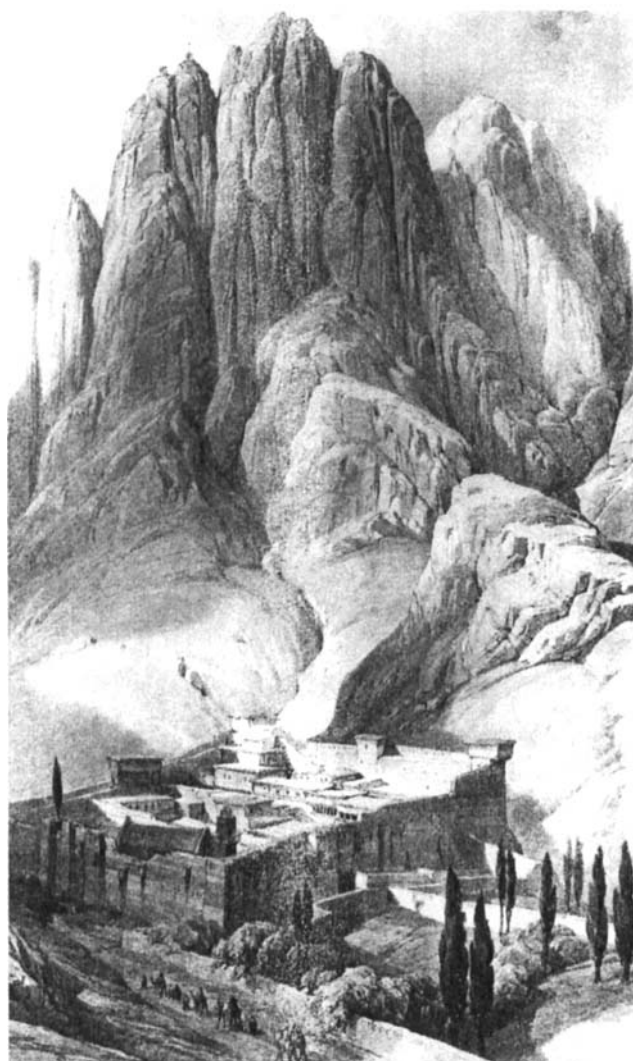


Fig. 16. Jebel Musa, supposedly Mount Sinai, western flank, the mountain of the giving of the law, at its foot: the monastery of St Katharine. The central dark part of the mountain is a late Precambrian neck of alkali-rhyolite, intruded into the surrounding lighter coloured alkali-granite; the lower, softer part of the mountain is built of older metasediments. A 19th century engraving by an unknown artist. Source: Wilson (1880, p. 69).

the mountain burned with fire unto the midst of heaven, with darkness, clouds and thick darkness' (the last two words should more correctly be translated by the term 'fog') (Figs 14 and 15).

Here we have what cannot be called otherwise than the oldest known description of a volcanic eruption based on very careful observation. In addition to the pillars of cloud and fire, the account contains no fewer than seven features, each characteristic of a volcanic explosive eruption: the noise of explosions ('thunder' and 'trumpet blasts'), flames or possibly electrical discharges ('lightning'), pyroclastics ('smoke') and volcanic earthquakes (the mountain was

quaking), a summit cloud and darkness. To this the reference to the same event in the song of Deborah (Judges 5:5) should be added: 'The mountains melted from before the Lord, even that Sinai from before the Lord God of Israel.' This theme is further elaborated by the prophet Micah (1:3,4), who lived at the end of the 8th century BC: 'For behold, the Lord cometh forth out of his place, and will come down, and tread upon the high places of the earth. And the mountains shall melt under him and the valleys shall be cleft, as wax before the fire and as water poured down a steep place.' This description, repeated in almost identical terms in Psalm 97:3-5, provides the one missing element: the molten rock or, to use a modern term, lava flowing down the flanks of the mountain. It is inconceivable that the authors could combine eight features, each of them characteristic of an active volcano, unless they had witnessed an eruption or at least heard of one.

The apparently obvious question is: is Mount Sinai (Wilson, no date; Skrobucha, 1966) really a volcano? The answer is positive but irrelevant; the volcanic activity on the mountain believed to be the Mountain of Moses took



Fig. 17. Jebel Musa, supposedly Mount Sinai, the mountain of the giving of the law. The steep light coloured upper scarps are a late Precambrian neck of alkali-rhyolite intruded into darker and softer metasediments. Wood engraving. Source: Skrobucha (1966, p. 112).

place in the late Precambrian (Figs 16 and 17). Moreover, the identification of this mountain with the original mountain of the law, if there is such a place, is a very doubtful one and most probably erroneous. More importantly, however: the question is wrong. The bible makes frequent use of geological events, but it is not a textbook of geology; it is a book of history and moral education. Thus, it does not care much about dates and places, shifting geological events around to suit its purpose. When the account of the giving of the law on Mount Sinai was written down, the narrators, considering this the most important event in the history of mankind and looking for a background worthy of this occasion, found it in the majesty of a volcanic eruption, clearly, they felt, the work of supernatural forces.

The real question therefore, is: could they have witnessed such an event, or at least listened to a description of it? Quaternary volcanism is widespread in northern Israel and in adjoining areas of Syria – the Jebel Druse area, and many volcanic cones are here still perfectly preserved (Fig. 18). The youngest lava flow so far dated – the E-Safa flow north-east of Jebel Druse – covered animal bones dated by C^{14} analysis to 2000 BC, i.e. a few centuries before the events at Mount Sinai (Ponikarov *et al.*, 1957). At the time of Mohammed (7th century AD), a volcanic eruption took place near Mecca. It is thus evident that the reporters of the events on Mount Sinai could well have witnessed volcanic activity, or at least heard the tales of such activity which, in a largely illiterate society, would have been transmitted faithfully and vividly down the chain of generations.

There is a very peculiar sequence of verses in the book of Job which seem related to volcanism:

*'Silver has its source
and there is a place for the refining of gold;
Iron is taken from the earth
and copper is smelted from rock;
he brings an end to darkness
and for every quest he studies darkness and gloom. . . .'* (Job 28:1–3.)
*'The earth from which cometh bread
below is transformed as by fire.'* (Job 28:5.)

The last verse is intriguing; does it mean that below the fertile surface of the Earth the temperature rises, causing metals to concentrate and rocks to change? Such an interpretation seems hard to avoid. In the absence of deep drillings or mining, as well as of seismographs, this concept can only be derived from the observation that hot molten rocks reach the cool surface from the depth of the Earth, and from this it follows that the author of the book of Job conceived the idea of geothermal heat and its link to ore deposits in the sixth century BC.



Fig. 18. Mount Peres, a subrecent volcano, Golan Heights. Oblique airphoto.

GEOLOGICAL CHANGES

People in antiquity generally held an essential static view of Earth; once created, the Earth does undergo seasonal cycles but no permanent changes. History and change were confined to mankind, and even here changes were frequently viewed as cyclic, as by the Egyptians and Hindus. The bible takes the opposite view, that of an Earth evolving and changing with time. A good example of this outlook is Psalms 107:33–35:

*'He turneth rivers into a wilderness,
and the watersprings into dry ground;
a fruitful land into barrenness,
for the wickedness of them that dwell therein.
He turneth the wilderness into a standing water,
and dry ground into watersprings.'*

In a language displaying a knowledge of the nature of the processes involved, rare if not unique for its time, the book of Job describes these changes: *'Water disappears from the sea and the riverbed is parched and dry . . .'* (14:13). *'Verily, the mountain disappears and crumbles and the rock is moved from its place; water wears down rocks and the flood sweeps away the dust of the land – thus you destroy the hope of man.'* (14:18, 19). This concept of a changing Earth, of nature in evolution, is possibly the deepest insight the bible achieved into a central aspect of geology.

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Harmon Craig went farther in suggesting that Job 41:31: 'He maketh the deep to boil like a pot: he maketh the sea like a pot of ointment.' obviously refers to submarine hydrothermal vents.

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