

COLIN J. HUMPHREYS and ROBERT S. WHITE **The Eruption of Santorini and the Date and Historicity of Joseph**

We suggest that a cataclysmic eruption of Santorini in the 17th century BC was responsible for major famines in Egypt and the surrounding area recorded in Old Testament writings in the account of Joseph, and we give arguments for the historicity of this account. Evidence of climatic disturbances in the northern hemisphere from tree-ring widths and of a huge acidity spike in ice cores from Greenland are consistent with widespread climatic modification at this time. We suggest that the famines occurred during the period of the Hyksos pharaohs of the Fifteenth Dynasty in Egypt, probably during the reign of King Khyan, thus providing a date for this pharaoh, and also for the Old Testament patriarch Joseph. If our arguments are accepted, the eruption of Santorini, for which we take the best date to be 1628 BC, provides an absolute chronological marker for both ancient Egyptian and ancient Hebrew chronology.

Keywords: chronology, dendrochronology, Egypt, famines, Hyksos Dynasty, Israel, Joseph, pharaohs, Santorini, volcanoes.

1. Introduction

When did the Old Testament patriarch Joseph live? Was he a real historical character?

Many historians and theologians regard the Joseph story as a literary composition, but not as history. For example, Redford¹ states 'the nine or so chapters [of Genesis] that comprise the Joseph story show all the earmarks of a composition, rather than a record . . . the Joseph story is in fact a novella or short story . . . the "poor fit" of the Joseph story extends to factual detail'. In a similar vein, Ahlstrom² writes 'the stories about the so-called pre-monarchic period starting with creation are not history. They are literary creations. Just as, for instance, Shakespeare wrote about Richard III, a biblical writer could compose a story about Abraham's journeys from Mesopotamia to Egypt or a story about Joseph and his brothers in Egypt. In these cases they have created some interesting pieces of literature, but not necessarily history'.

On the other hand, many biblical scholars do regard Joseph as an historical person. The account in Genesis portrays him as such and sets him in a clear historical context. Joseph is referred to as an historical person in the New Testament, and has been traditionally regarded as historical by both Jews and Christians. However, the dates suggested for Joseph by biblical scholars who do believe in his historicity range from

1900 to 1350 BC (1900 BC accords with time spans and chronologies given in the Old Testament if these are all taken as both literal and consecutive years. However, most biblical scholars believe that Joseph lived later than this, and as late as c.1350 BC has been suggested³). This lack of agreement on the date of Joseph clearly weakens the case for historicity. The purpose of this paper is to suggest that Joseph can be dated from the known date of a massive volcanic eruption, and to show that even minor geographical and political details in the account of Joseph in Genesis are consistent with this date, thus strongly supporting an historical interpretation.

The book of Genesis records a seven-year famine in Egypt and the surrounding lands at the time of Joseph (Gen. 41–47, see also Acts 7:11). If historical, this was an extraordinary event because ancient Egypt owed its agricultural prosperity to the regularity of the annual flooding of the Nile. The probability of the Nile not flooding for seven consecutive years is extremely small (see later). Even if the Nile did not flood for seven years, this would not explain the famine in neighbouring lands such as Canaan, recorded in Genesis. We therefore conclude that an alternative cause should be sought for the seven-year famine in Egypt and the neighbouring lands.

Historical documents themselves usually contain only relative chronologies. For example, ancient Egyptian king lists require known chronological markers if actual dates are to be assigned, and some biblical genealogies are known to be incomplete. It is probably not an exaggeration to state that it is only when science can be used to establish the dates of ancient events described in historical documents (for example, by calculating the date of a solar eclipse referred to in a document) that we can have certainty and precision. Thus science can be used to reconstruct the chronology of the past, and hence to underpin ancient history.

Two nations whose histories have profoundly affected mankind are Egypt and Israel. The relative chronology of the pharaohs of ancient Egypt is reasonably well established back to at least 2000 BC, apart from the 'dark age' of the Hyksos pharaohs (c.1600 BC). The dates, and even the order, of individual Hyksos pharaohs are not known with any certainty (see later). The relative chronology of Israel is reasonably firm back to c.1000 BC, but prior to this date it becomes increasingly uncertain. A major problem is that no scientifically dateable chronological marker relevant to Egypt and Israel has been established earlier than 1000 BC. In this paper we suggest that the eruption of Santorini (a volcanic island in the Mediterranean off the coast of Greece) may provide such a marker, which enables the date of the Old Testament patriarch Joseph to be established and which throws light on the dates of the Hyksos pharaohs.

2. The Eruption of Santorini

The eruption of Santorini (Thera) was one of the largest volcanic events in the last four millennia. Some 30 cubic kilometres of rock was erupted,⁴ and

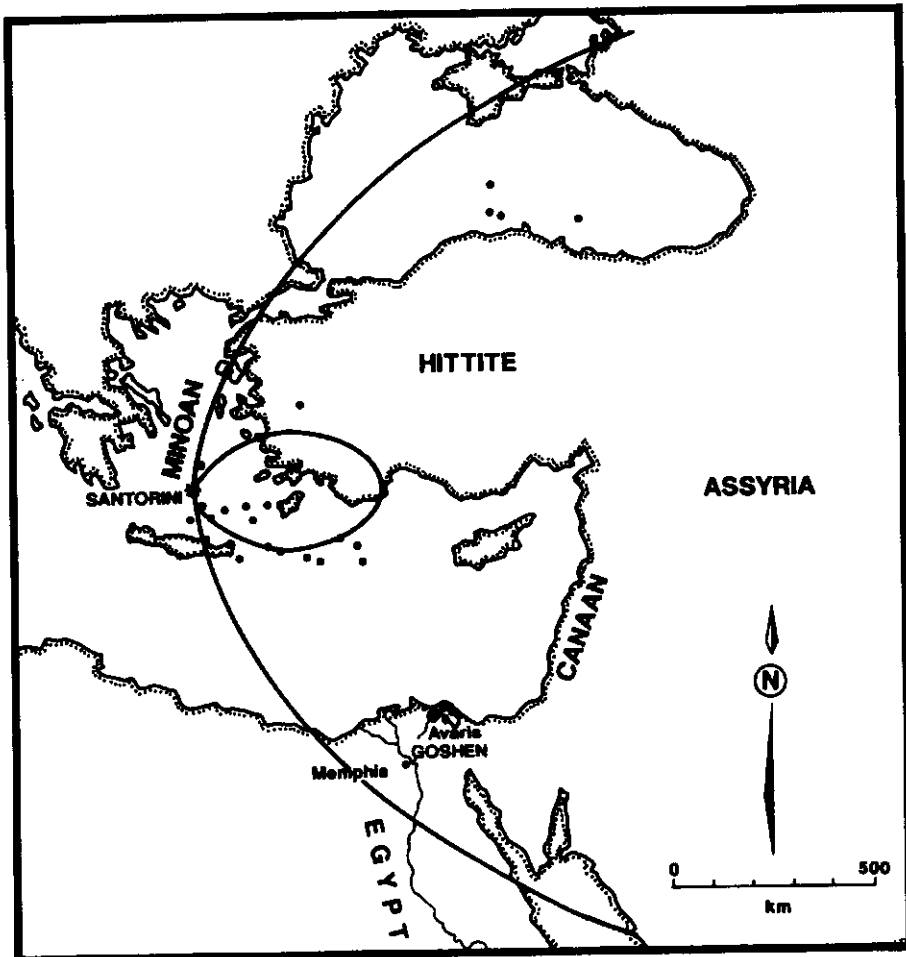


Figure 1 Map showing the location of Santorini, the identified ash fallout extending over Egypt and the Near East, and the locations of Egyptian cities mentioned in the text. Dots show the location of cores from which Santorini deposits have been recognised. Outer curve indicates overall extent of the ash fall; inner curve outlines region where ash is more than 100 mm thick (after D.M. Pyle, University of Cambridge).

ash from the eruption has been identified across an area of more than 2 million square kilometres extending from the Black Sea in the north⁵ through Turkey⁶ and the south-eastern Mediterranean⁷ to the Nile delta in the south⁸ (Figure 1). The likely impact of this massive eruption on the climate in the northern hemisphere has been mentioned by several authors.⁹⁻¹² Some have postulated that the Egyptian plagues recorded

in Old Testament writings may have been caused by fallout from Santorini.^{8,13} However, the Egyptian plagues and subsequent Exodus of the Israelites from Egypt probably occurred around 1300 BC, several hundred years after the eruption of Santorini.

Radiometric dating using corrected ¹⁴C from grain and timber samples found at Akrotiri on the island of Santorini suggests that the eruption occurred during the period 1500–1650 BC.¹⁴ For samples of this age, the ¹⁴C radiometric dating technique has uncertainties of at least 100 years, and potentially several hundred years. More precise dates can be obtained from ice-cores and from dendrochronology, because both these methods retain annual markers that can be counted back from the present day. The most complete ice cores extending back to the 17th century BC and earlier come from the Greenland ice cap. Large acidity spikes measured in ice cores have been attributed to the acidic fallout from volcanic eruptions. The largest such ice-core acidity spike in the period 2000–1200 BC⁹ is found at 1645 ± 20 BC, indicative of a cataclysmic eruption at this time. Tree-ring data also show evidence of a major climatic disturbance in the northern hemisphere at the same time, within the uncertainties of dating. Exceptionally narrow tree-ring growth over a period of several years has been reported from places as far apart as the western USA [dated 1628–1626 BC¹¹], and Northern Ireland [dated 1628 BC¹²].

Both the ice-core acidity and tree-ring growth anomalies have been attributed to climatic aberrations caused by an eruption of Santorini in the 17th century BC.^{11,12,15} The best date for this eruption, consistent with all the data, is then 1628 BC. However, we note that it is not at present possible to attribute this climatic disruption unambiguously to Santorini, since three other large eruptions occurred in the northern hemisphere during the period spanned by the 15th to the 18th centuries BC. These comprise two large eruptions in the Alaskan Peninsula at Aniakchak [1480 BC¹⁶] and Veniaminof [1750 BC¹⁶] and one eruption of Vesuvius [1740 BC¹⁷]. All three dates are from uncorrected ¹⁴C measurements, and could conceivably correspond, within their uncertainties, to the 1628 BC date from dendrochronology. A fourth alternative possibility is an eruption of Mount St Helens in the western USA in 1855 ± 50 BC^{17,18} (corrected ¹⁴C date), although this is sufficiently far removed in time from 1628 BC to be an unlikely candidate for the climatic aberration. At present it is not possible to determine unambiguously which of the eruptions corresponds to the 1628 BC disruption, although it is possible that future geochemical ‘fingerprinting’ of the minute quantities of dust preserved in the ice core will point to one particular volcanic source.

In this paper we assume, along with other authors,^{11,12,15} that the 1628 BC climatic anomaly was caused by the eruption of Santorini, though the arguments we give for the effect of Santorini in causing the famines recorded in the Old Testament do not depend on this correlation.

3. Climatic Effects of Volcanic Eruptions

Paroxysmal eruptions can disrupt the biosphere by four main effects: tsunami (popularly known as tidal waves) may inundate surrounding low-lying land (for example, the explosion of Krakatau in 1883 generated a 30 m high tsunami and caused 35,000 deaths by drowning); sulphur aerosols circulating in the stratosphere may cause globally lowered temperatures for a period of several years; toxic elements such as fluorine may cause death if ingested; and sulphur, which precipitates within a few days as acid rain, may stunt or kill vegetation over huge areas downwind from the eruption.¹⁹

A well documented example of a major famine caused by toxic volcanic gases is the Haze Famine of 1784–86 in Iceland, which resulted from a 15 cubic kilometre basaltic lava eruption from Lakagígar in 1783. An estimated 13–63 million tonnes of SO₂ were degassed, producing about 100 million tonnes of sulphuric acid.²⁰ This stunted the growth of grass and in the following years resulted in the death of about 75% of the livestock and 24% of the population.^{21,22} The eruption column reached transient maximum heights of 13 km, sufficient to inject dust and sulphur aerosols into the lower stratosphere. Fallout of dust and ashes from the eruption was recorded as far away downwind as northern Africa, and temperatures in the northern hemisphere in the following year are estimated to have dropped by about 2°C.²³

The Haze Famine may provide a good analogue for the Egyptian famine at the time of Joseph. In Iceland, fatalities were high because the island is relatively isolated, the volcanic gases affected the entire area and the agrarian system was fragile because the region lies at a high latitude. In Egypt the agricultural system was likewise fragile, due to the equally harsh, though in this case hot and dry, climate and the crucial dependence on the Nile floods. Genesis 41:54 states that the famine which affected Egypt also spread over surrounding countries in the Middle East. This entire area lay downwind from Santorini (Figure 1).

The Santorini eruption produced a Plinian column about 36 km high,²⁴ more than twice as high as the Lakagígar eruption, and injected dust and sulphur into the stratosphere. An estimated 17–192 million tonnes of sulphuric acid was subsequently rained back to earth: the lower estimate comes from inclusions in the ash fallout,²⁵ which cannot account for degassing not trapped in erupted magmas, whilst the upper estimate comes from the magnitude of acidity spikes measured in Greenland ice-cores. Huge volumes of acid rain, dropping preferentially onto the downwind area in which Egypt lies (Figure 1), would have had a severely detrimental effect on agriculture. Sulphur aerosols and dust injected into the stratosphere could also have caused crop failure, as a consequence of lowered temperatures that probably lasted for three or four years. If a tsunami flooded the low-lying Nile delta area, then not only might crops

have been destroyed as a result of the flooding, but the salt left behind may have drastically reduced crop yields for several years.

4 The Famine in Egypt at the Time of Joseph

Although there are compelling arguments for a link between the explosive eruption of Santorini and crop failure in Egypt, it is pertinent to ask how the famine could last as long as the 7 years recorded in Genesis. Although 'seven' may be symbolic for 'many', it is clear from the various events listed as occurring during the years of the famine that it lasted for approximately 7 years. Several factors might have served to prolong the immediate effects of dust and acid rain fallout, and the subsequent climatic deterioration which may have lasted several years. Egyptian agriculture was dependent on the annual Nile floods, which failed on average about one year in ten.²⁶ Failure during the period when the crops were already under pressure may have prolonged the famine. Salt water ingress to the crucial Nile delta area could have degraded productivity in that region for many years. Recovery from famine can itself take several years until the supply of seed corn is again rebuilt, and stable production resumed. All these factors could have played a part in prolonging the famine to an approximately 7 year span, although the initial cause was the violent explosion of Santorini some 800 km up-wind.

Is the suggestion that the long famine in Egypt and the neighbouring countries at the time of Joseph was due to the eruption of Santorini, consistent with ancient Egyptian and Hebrew documents? In 1628 BC the Hyksos 15th Dynasty, which formed part of the Second Intermediate Period, was ruling Egypt. 'Hyksos' is from the Egyptian term for 'rulers from foreign countries', and the Hyksos Dynasty consisted of foreign pharaohs of Asiatic origin.^{1,27} According to the Turin Canon of Kings, the Hyksos 15th Dynasty spanned 108 years and a detailed recent analysis of the dates of this Dynasty gives either 1648–1540 BC (high chronology) or 1637–1529 BC (low chronology),^{28,29} depending on the dates for later pharaohs. We here adopt the high chronology, and comment on this assumption at the end of the paper.

Herodotus called Egypt 'the gift of the Nile' because the regular annual flooding of the Nile, due to the annual monsoon rains and snow thaw in the mountains of Ethiopia, underpinned Egyptian farming which in turn undergirded the long and successful ancient Egyptian civilisation. However, occasionally the Nile did not flood, leading to famines which were noted in the Egyptian records of the times. From compilations of Egyptian famines mentioned in surviving documents,²⁶ it seems that the lack of flooding of the Nile occurred at random about once per decade, as noted earlier. Thus a famine lasting one year occurred about every ten years, a famine lasting two years occurred about once every hundred years, and so on. It is clear that the probability of a seven year famine, as recorded in Genesis, being due to seven consecutive years of non-flooding of the Nile is

remote and a different cause, such as the eruption of Santorini suggested here, should be sought.

The foreign Hyksos pharaohs were hated by subsequent pharaohs of Egyptian origin and hence very few records of the Hyksos dynasty have survived. It is a dark period in Egyptian history. In particular, Vandier²⁶ notes that one would have expected many famines to have occurred during this period, but he could find no recorded evidence. Van Seters,²⁷ however, dates a literary work 'The Admonitions of an Egyptian Sage Ipuwer' to the Hyksos period (although this date is contested, e.g. Ref. 1, p.66). This text states 'the Nile overflows, yet none plough for it . . . the river is blood, yet men drink from it . . . the desert is throughout the land . . . barbarians from abroad have come to Egypt . . . taking our grain . . . cattle moan because of the state of the land . . . the writings of the scribes are destroyed and the corn of Egypt is common property'. If this text is describing the Hyksos period then it would appear to be consistent with the effects suggested in this paper of the eruption of Santorini on Egypt, leading to a famine even though the Nile overflowed. The corn of Egypt being common property is also described in Genesis 41:56.

5. The Date of Joseph

As noted earlier, the dates suggested for Joseph by biblical scholars range from 1900 to 1350 BC. Thus the date assigned to Joseph ranges by over 500 years. The Genesis account of Joseph enables this date range to be reduced significantly independent of the Santorini argument given here. First, there is a political argument. Genesis 41:40 states that Pharaoh appointed Joseph to be his second-in-command. It is well documented that many pharaohs had a vizier (second-in-command) to whom they delegated extremely substantial responsibilities [such as the treasury, armed forces, and agriculture³⁰]. It is unlikely that an Egyptian pharaoh would appoint a Hebrew as his second-in-command, to have such large responsibilities, including oversight of the Egyptian armed forces and national finances. The most plausible time for Joseph to be appointed vizier was when Egypt had a foreign king. Apart from the Hyksos kings (c.1648–1540 BC) the other possible foreign kings were Khendjer, who reigned for a few years in c.1750 BC, and 'Ameny the Asiatic', who reigned for less than ten years in c.1770 BC (Kitchen, private communication). Relatively few Egyptian pharaohs reigned for long periods. The Genesis account suggests that the pharaoh at the time of the Joseph famine reigned for at least 28 years (see Genesis 41:1, 29; 47:28; 50:4). We can therefore rule out both Khendjer and Ameny the Asiatic as possible pharaohs at the time of Joseph since both reigned less than 10 years. The most probable time for Joseph to have been vizier was therefore during the Hyksos 15th Dynasty.

Second, there is a geographical argument. Joseph lived near his father (Genesis 45:10) who lived in Rameses (Genesis 47:11). Rameses was in Goshen, a region in the north-eastern part of the Nile Delta (Fig. 1). Since

Joseph the vizier would have lived in the Egyptian capital, we infer that the capital at the time of Joseph was in or near to Rameses. In the period 1900–1350 BC, the range proposed by others for Joseph, the Egyptian capital shifted between Thebes, Ithat-Tawy/Memphis and Avaris. The 12th Dynasty (c.1991–1785 BC) moved the capital from Thebes (now called Luxor) to Ithat-Tawy (south of Memphis), about 150 km south of Rameses, and also established a summer residence in the East Delta at Ro-waty, which became Avaris, and later Rameses. The Hyksos upgraded Avaris to be a second capital, alongside Memphis/Ithat-Tawy. After the Hyksos, Avaris was not prominent again until 1300 BC. Avaris is the only Egyptian capital that fits the Genesis description of Joseph living close to his family in Rameses. Thus, arguing from geography, the most likely time for Joseph was during the Hyksos dynasty. Two separate arguments, one political and one geographical, based upon the evidence in Genesis therefore point to Joseph living at some time during the Hyksos dynasty (c.1648–1540 BC).

6. The Egyptian Pharaoh at the Time of Joseph

The chronology of the Hyksos kings has been uncertain and confused for many years (e.g. Ref. 1, p.98–122). The Turin Canon of Kings (written c.1250–1200 BC) has six kings for the Hyksos 15th Dynasty, as does Manetho writing a millennium later, and it is now generally accepted that the Hyksos Dynasty had six kings. The time span of 108 years for the Hyksos 15th Dynasty given in the Turin Canon of Kings is also generally accepted. However, in three fragments of Manetho's *Aegyptiaca* quoted by Eusebius, Africanus and Josephus (the original Manetho text has not survived), different time spans are given for the reign of each king and the order of the last three kings varies. The order and names of the kings also vary widely in other ancient sources (e.g. Ref. 1).

The Manethonic data uniformly give the first three kings as Salitis (elsewhere called Sheshy), Bnon (or Ya'kob-har) and Apachnan (or Pachnan). One possibility is to accept this order, and to have the last three kings as Khyan (elsewhere called Khayan, Staam or Iannes), Apophis and Khamudi. We can be reasonably certain of the order of the first (Salitis) fifth (Apophis) and sixth (Khamudi) of these pharaohs (Kitchen, private communication, also see Refs 1 and 32).

It is known from the Rhind Mathematical Papyrus that Apophis ruled for at least 33 years, and there is a stray '40 years plus' in the Turin Canon of Kings which it seems belongs to Khyan. Since the Hyksos Dynasty lasted 108 years, the remaining four Hyksos kings reigned for a maximum of about 30 years between them. Thus the only two Hyksos kings who ruled long enough to satisfy the description in Genesis of the pharaoh at the time of Joseph were Khyan and Apophis. We can rule out Apophis as being too late to be the pharaoh at the time of the Joseph famine. The last Hyksos king, Khamudi, had a short reign, probably of about 5 years from c.1545–1540 BC. If Apophis reigned for, say, 35 years then his dates would have been

c.1580–1545 BC, i.e. he started his reign about 50 years after the 1628 BC volcanic eruption. Thus, by elimination, the pharaoh at the time of the Joseph famine must have been Khyan. It is of interest to note that Khyan was one of the two 'great' Hyksos kings (the other being Apophis). For example, Khyan is named on monuments in both Upper and Lower Egypt, and on cylinder seals and scarabs not only in Egypt but on objects found as far away as Palestine, Baghdad and Crete, bearing witness to Egyptian prosperity and to widespread trade during his reign.¹ According to Genesis, the pharaoh at the time of the famine owed his subsequent prosperity, at least in part, to the famine, and to the grain he was able to sell to those desperate for food. Thus Gen. 47:20–21 records 'so Joseph bought all the land in Egypt for pharaoh . . . Joseph reduced the people to servitude, from one end of Egypt to the other'. This is consistent with Khyan being called, in a document contemporary with the Hyksos Dynasty, 'He who encompasses the Lands' (the Lands being Upper and Lower Egypt). Genesis also records how the land of Canaan purchased grain from Egypt (Gen. 47:14) and how, some years later, court officials of the same pharaoh accompanied Joseph to Canaan (Gen. 50:7). This is consistent with the widespread international influence Khyan is known to have had. Thus various details of the Joseph account fit well with the pharaoh-of-the-famine being Khyan.

The Genesis account suggests that the pharaoh at the time of Joseph ruled for at least nine years before the famine started (seven years of plenty plus two years when Joseph was in prison before this, Gen. 41:1). Thus Khyan started to reign c.1637 BC. If we accept the order of kings given above, then Khyan reigned from c.1637–1580 BC, i.e. for about 57 years, and the first three Hyksos kings had a total of 11 years between them (c. 1648–1637 BC).

An alternative possibility is to argue that since the order of the last three Hyksos kings in Manetho is chaotic, then his order for the first three is not reliable either. Both Redford (Ref. 1, p.110) and Bietak³² suggest that the order of the six kings should be Salitis, Ya'kob-har (or Bnon/Pachnan), Khyan, Yanassy, Apophis and Khamudi. If we keep the date of Apophis as c.1580–1545 BC and give Yanassy ten years, then Khyan spanned the period c.1637–1590 BC, a reign of 47 years, and the first two kings spanned 11 years between them (c. 1648–1637 BC). This latter scenario would seem to provide a more likely chronology than the one given above, with Khyan being the third Hyksos pharaoh as suggested by Refs 1 and 32. Both scenarios are consistent with the high chronology (1648–1540 BC) for the Hyksos Dynasty but not with the low chronology (1637–1529 BC).

7. Conclusions

In summary, a consistent picture emerges. It can be deduced from the Old Testament that Joseph lived at the time of a Hyksos pharaoh who had a long reign. The only possibilities are Khyan and Apophis. Independently we suggest that the long period of famine in Egypt at the time of Joseph was

due to the Santorini eruption in the seventeenth century BC. A large climatic disturbance in the northern hemisphere occurred during 1628 BC and the immediately following years. We have assumed, as others have, that this was caused by the eruption of Santorini, though we note that this is not yet proven unambiguously.

Assuming that the 7-year famine started in 1628 BC, this date is too early for Apophis but is consistent with the date of Khyan if the 'high chronology' is assumed (and the Egyptian chronology of pharaohs is not based on an assumed date for the Santorini eruption). Thus independent arguments point to the date of the start of the famine in Egypt at the time of Joseph being 1628 BC, and we suggest that Khyan was the pharaoh at that time. If these arguments are accepted, then a massive volcanic eruption, probably that of Santorini, that can be dated to 1628 BC, forms an absolute chronological marker both for Hebrew history (the date of Joseph) and for Egyptian history (the date of Khyan). In addition, one of two main chronologies for the Hyksos Dynasty supported by Egyptologists, the low chronology of 1637–1529 BC, is ruled out as being too late.

Having established that Joseph lived at the time of the Hyksos Dynasty we can now comment on the probable date of the writing of the Joseph account in Genesis. The average price of slaves, and other commodities, in the ancient world rose gradually during the course of time (in a similar fashion, the price of bread and other commodities normally rises over time in the modern world). As Kitchen³³ has shown, from ancient non-biblical records, in the late 3rd millennium BC in Mesopotamia the average price of a slave was 10–15 shekels of silver. Joseph was sold to the Ishmaelites for 20 shekels of silver (Gen. 37:38), precisely the known price in the period c.2000–1500 BC. In the period c.1400–1200 BC the price had risen to 30 shekels (see also Ex. 21:32) and by 800 BC the price was 50 shekels and higher (consistent with 2 Kings 15:20). The fact that the Old Testament correctly records the increasing price of slaves, independently known from non-biblical literature, suggests strongly that at these points at least the Old Testament writings are based upon accurate traditions from the period in question and are not literary compositions written much later (e.g. as claimed in Refs 1,2). In particular, the detail of the 20 shekels of silver in the account of the life of Joseph suggests that the account was recorded soon after the events, as also happened with many ancient Egyptian records, although the final compilation of Genesis from such earlier sources may have occurred much later. Thus geographical, political and economic (the price of slaves) aspects of the Joseph account in Genesis are all consistent with Joseph living in the 17th century BC, at the time of the Hyksos pharaohs. We also note that if the Joseph story was a literary creation^{1,2} written relatively late, for example in post-Exilic times, then it is surely more likely that Joseph the vizier would have been located at the classic Egyptian capitals of Thebes (Luxor) or Ithas-Tawy (Memphis) rather than at the Genesis location of close to Rameses. Only a writer with historical knowledge of the Hyksos Dynasty would have given this latter

location. The consistency in detail strongly supports the historicity of the Joseph account rather than it being a literary short story. We suggest that the 'pharaoh of the famine' was the great Hyksos king Khyan, and that the famine started in 1628 BC.

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