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Amenhotep III's Mansion of Millions of Years in Thebes (Luxor, Egypt): Submergence of high grounds by river floods and Nile sediments

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ABSTRACT

New Kingdom royal cult temples in Thebes (Luxor, Egypt) are all located on the lower desert edge. Kom el-Hettân (Amenhotep III: reign 1391–1353 BCE, 18th Dynasty) is an exception, as it is located in the present Nile floodplain. Its anomalous position has puzzled Egyptologists, as has the termination of its use, which traditionally has been attributed to natural hazards such as flooding or earthquakes. Geoarchaeological analyses of the subsurface shows that Amenhotep III's temple was initially founded on a wadi fan that stood several metres above the contemporary surrounding floodplain landscape. The temple was fronted by a minor branch of the Nile, which connected the temple to the wider region, but the temple itself was relatively safe from the annual flood of the Nile. This geoarchaeological study comprised a coring programme to determine the c. 4000-yr landscape history of the local area. Chronological control was provided by the analysis of ceramic fragments recovered from within the sediments. This study shows that the New Kingdom period was, at least locally, characterised by extremely high sedimentation rates that caused a rapid rise of the floodplain and gradual submergence of the pre-existing high temple grounds. This is, however, not a plausible reason for the destruction of the temple, as frequent inundation did not begin until the temple was already out of use and largely dismantled.

1. Introduction

The low desert adjacent to the West Bank of the River Nile in the Luxor region, Egypt (Fig. 1), is dominated by the monuments of the Theban necropolis. At the end of the Second Intermediate Period (for historical periods and dates of reigns see Table 1), the ruling elite from Thebes defeated the Hyksos rule in the north and succeeded in reuniting Lower and Upper Egypt into the New Kingdom state (Bourriau, 2005). Thebes was established as the new capital city; a position which it retained until the reign of Akhenaten (van Dijk, 2000; Kemp, 2012). Thebes remained a major cultural and religious centre throughout the New Kingdom and thereafter (Strudwick and Strudwick, 1999; Bryan, 2000). The New Kingdom saw most rulers construct a Mansion of Millions of Years (a royal cult temple), known from textual sources and extant complexes (Ullmann, 2002, 2016). The known surviving temples are all found on a narrow strip of desert adjacent to the floodplain (Fig. 1), out of reach of annual Nile floods. Amenhotep III's temple (present day Kom el-Hettân), however, occupies an anomalous position as nearly the entire complex appears to protrude from the desert edge into the current floodplain (Fig. 1).

Bryan (1992) and Assmann (2005) have suggested that Amenhotep III's Mansion of Millions of Years, thought to have been the largest temple in its time (Bryan, 1992), was built in the low-lying floodplain with the intention of being flooded. This would have symbolised

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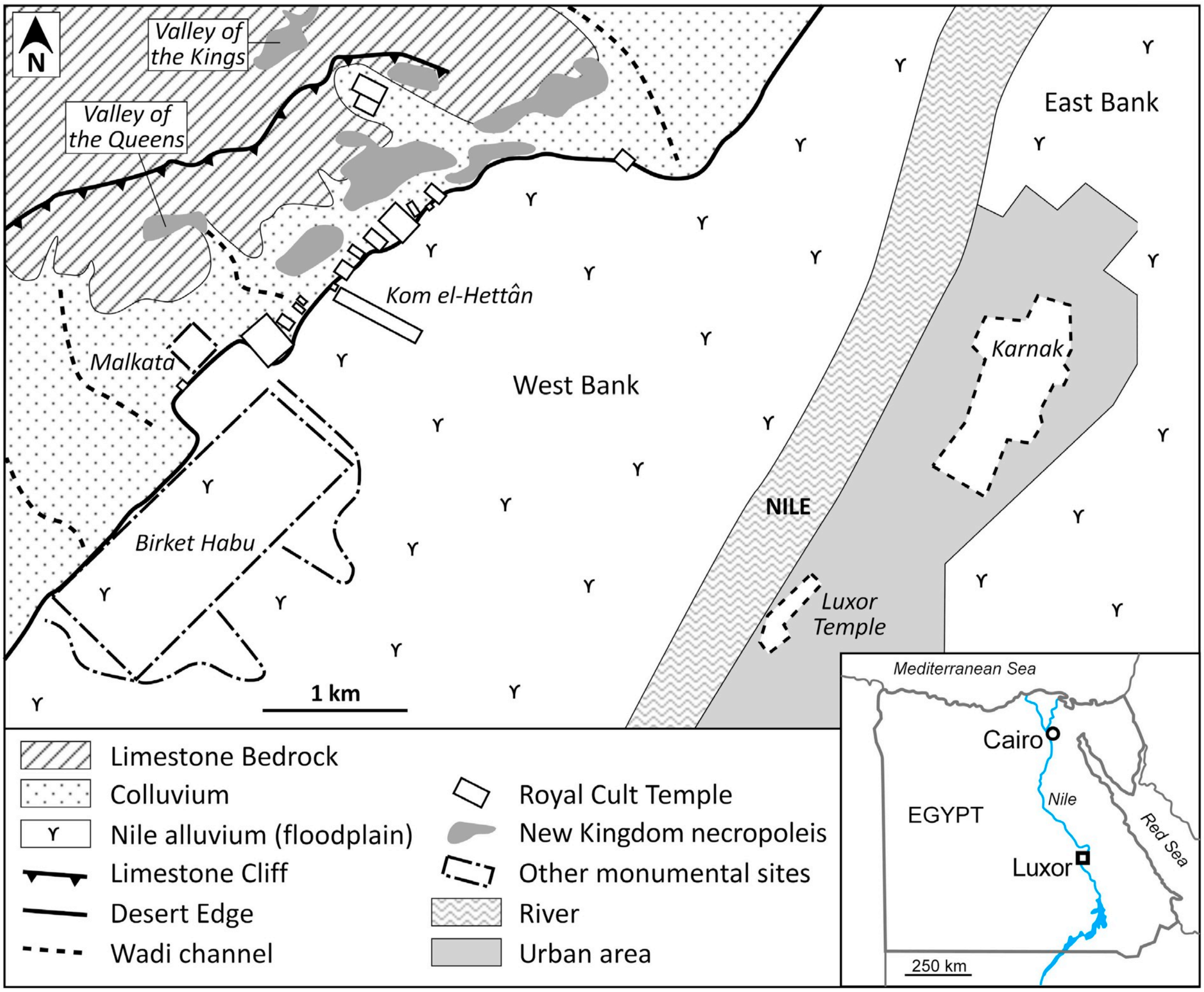

Fig. 1. Overview of the research area with the locations of main New Kingdom archaeological sites. Most New Kingdom royal cult temples are located on the desert edge, out of reach of annual Nile floods.

Table 1
Summary of historical periods and dates for Upper and Lower Egypt (dates after Hornung et al., 2006).

Period of Egyptian history	Dynasties	Dates (BCE)
Old Kingdom	4th–8th	2543–2120
First Intermediate Period	9th–11th	2118–1980
Middle Kingdom	11th–13th	1980–1630
Second Intermediate Period	14th–17th	1630–1539
New Kingdom	18th–20th	1539–1077
18th Dynasty	*18th*	*1539–1292*
Amenhotep III	*18th*	*1390–1353*
Akhenaten (Amenhotep IV)	*18th*	*1353–1336*
Ramesside Period	*19th–20th*	*1292–1077*
Merenptah	*19th*	*1213–1203*
20th Dynasty	*20th*	*1190–1077*
Third Intermediate Period	21st-25th	1076–655
Late Period	26th-31st	664–332
Macedonian and Ptolemaic Period	–	332–30
Roman and Byzantine Period	–	30 BCE–641 CE
Islamic Period	–	641 CE–present

rejuvenation, as the flood recreated the ‘primordial mound rising from the Waters of Chaos’ in Egyptian cosmogony. Floods have also been hypothesised to have been a potential cause for the destruction of the temple, which occurred during the Ramesside Period. Construction materials from Kom el-Hettân were reused in Merenptah's royal cult temple (Bickel, 1992), which was erected only c. 150 years after Amenhotep III's temple (Table 1). Ricke (1981) argued that the destruction of the temple was caused by an earthquake that occurred early in the reign of Merenptah. A suggestion that is supported by Karakhanyan et al. (2014), who provide examples of seismic damage to many ancient monuments in the Theban region. The iconic 17–18 m high colossal seated statues of Amenhotep III (Colossi of Memnon; Fig. 2), which fronted the temple, largely survived the destruction in Pharaonic times.

The temple of Amenhotep III was dedicated to the cult of the king and his father; the god Amun. The primary goal of the temple was the regeneration of the deceased king through daily service to his cult (Ullmann, 2016), which was designed to carry on into perpetuity. This eternal function of the temple seems, however, in conflict with its placement in an apparently vulnerable location, potentially on top of soft, unstable floodplain clays and in reach of destructive Nile floods (Graham et al., 2014). Yet, Amenhotep III is well known for his grand building schemes, many of which were highly innovative (Bryan, 1992; Johnson, 1998).

In this study, borehole data were retrieved from the subsurface of the temple complex and its surrounding landscape. This survey was aimed at reconstructing key changes of the river landscape over the last four millennia that could provide valuable information on the selection of the location for temple building, and allows testing of the hypothesis that the temple was destroyed by floods. In a wider perspective, this investigation provides an example of how ancient Egyptian riverside culture utilised the geomorphology of the fluvial landscape (Butzer,

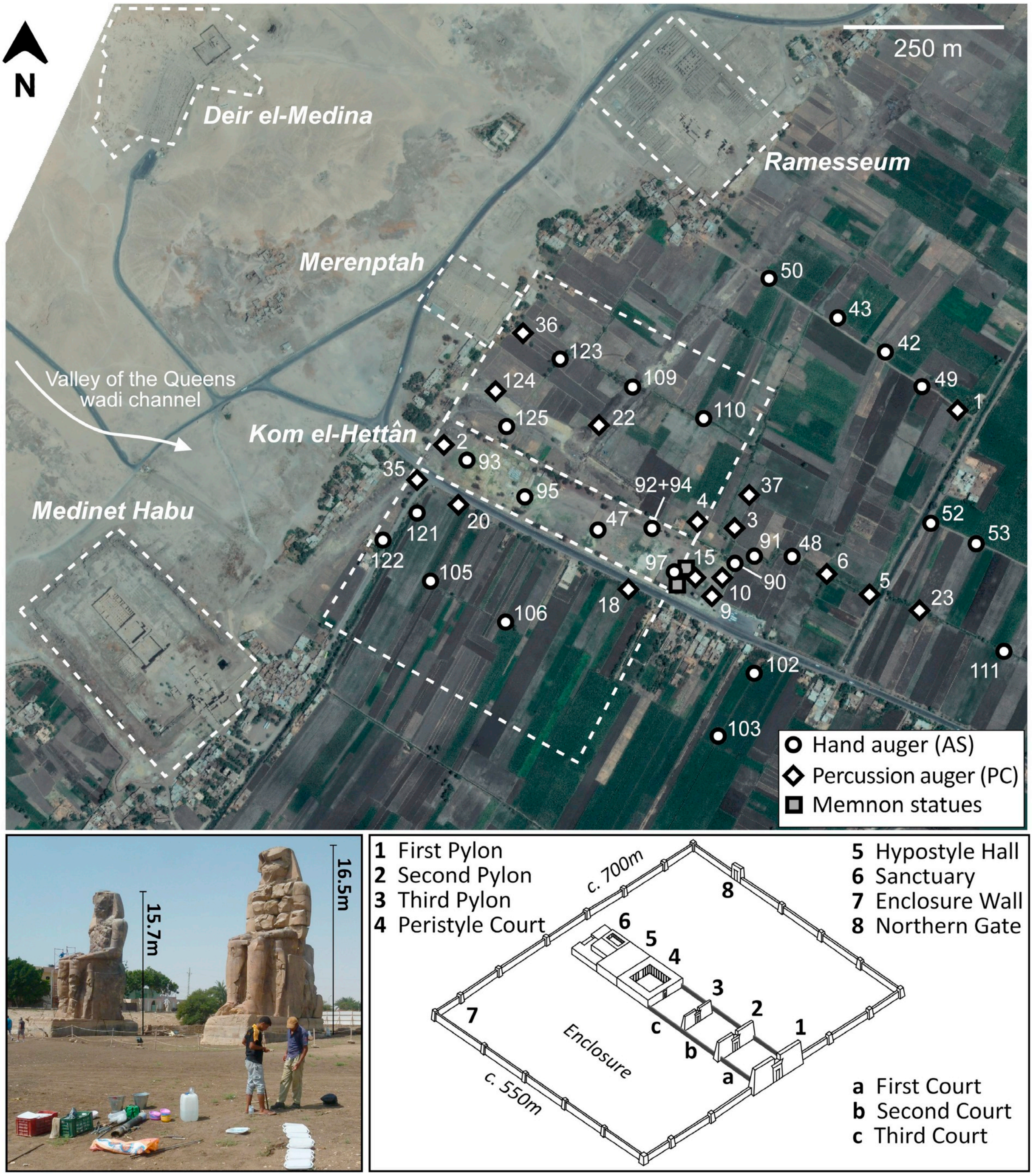

Fig. 2. (upper frame) QuickBird image of the research area with the position and suggested extent of Kom el-Hettân, and borehole locations. Lower frames: Colossi of Memnon (left), and (right) a reconstruction of Amenhotep III's royal cult temple complex (adapted from Sourouzian, 2015).

1976; Hassan, 1997; Macklin and Lewin, 2015), and what their exposure was to natural hazards and changes in such dynamic environments (cf. Woodward et al., 2017).

2. Methods and materials

2.1. Geological survey and ceramic dating

The reconstruction of the past fluvial landscape required; i) the analysis of sedimentary deposits to identify pre-existing landforms and to interpret their main formative processes, and ii) dating information to assign ages to these features. Dating information also allows for the calculation of long-term sediment accumulation rates and for relating important changes in the landscape (e.g. river relocations) to regional dynamics in cultural activity (e.g. Toonen et al., 2018). Sediments were extracted from 45 boreholes (Fig. 2), drilled with a Ø 7 cm Edelman hand auger or a Ø 10 cm Eijkelkamp window sampling percussion corer. Borehole locations were selected according to specific research questions: (i) to investigate why the NW-SE aligned strip of land underlying the main temple axis was considered suitable for construction; (ii) to compare the subsurface of different sections of the larger temple complex; and (iii) to fit the location of the temple complex into the dynamic configuration of the regional fluvial landscape.

Coring of each borehole was usually continued until sandy deposits were encountered; at a maximum of c. 11 m below the present surface. Boreholes within the temple were generally positioned in archaeological excavations to avoid temple debris. Borehole locations and surface elevations were recorded using a Leica Real Time Kinetic base-rover GNSS system, which was referenced to the local Survey of Egypt Datum (Graham et al., 2014).

From each borehole, sedimentary samples were recorded and bagged in 10 cm intervals. Lithological characteristics were logged in the field; e.g. grain size, texture, sorting, colour, organics and palaeosol features (see Supplement). Ceramic fragments and other clasts larger than 2 mm were extracted from each sample by wet sieving. 5755 ceramic fragments larger than 4 mm were studied and assigned an age, according to the Karnak fabric/dating system (Supplement). Due to the often-abraded nature of ceramic fragments in fluvial settings and the usual occurrence of common fabrics, dating precision derived from individual specimens was often limited to a broad Middle Kingdom to Roman Period age range. However, diagnostic ceramic fragments from more specific periods were also found at multiple levels in nearly every borehole; e.g. exclusive to the New Kingdom or even to a specific Dynasty. Such specific dating information, constraining the broader age estimates from the bulk of ceramics, generally came from fragments with a distinct technology or surface treatment, a diagnostic shape, or a characteristic fabric (e.g. marl, kaolinite, Oasis or non-Egyptian fabrics; Fig. 4). Our permit did not allow us to collect samples for radiocarbon or Optically Stimulated Luminescence dating. Instead we used the Karnak ceramic dating system for age information - this system is based on well-dated stratigraphical contexts of archaeological studies, radiocarbon dates, the chronology of seal imprints, and it corresponds with other generally deployed dating systems (e.g. the Vienna system) for ceramics found in and around ancient Egyptian temple complexes (references in Supplement).

2.2. Ancient flood levels

Historical flood markers, recorded on tribunes at Karnak and Medinet Habu (Fig. 1; Table 2), were studied to investigate *if*, *when*, and *how* severe floods inundated the floor levels of Amenhotep III's royal cult temple. The levels of markers were recalculated into local levels for Kom el-Hettân, based on an estimated 6.75 cm/km gradient of the regional landscape in pre-modern times (Ventre, 1896; Seidlmayer, 2001) and the down-valley distance between the site of flood level recording and Kom el-Hettân. Except for one major flood in the time of Thutmose III (Table 2), most of the recorded events are dated to the Third Intermediate Period, i.e. after the temple was already out of use. Recording in that period also covers floods of more regular occurrence and moderate magnitude: approximately 5-yr return interval flood events. Such flood heights are an important indicator for estimating the average regional floodplain level at that time. Together with local dating information from ceramics, this allows to make an approximation of the long-term aggradation rate of the floodplain. The gradual rise of floodplain levels is an important factor in the inundation frequency of local sites in addition to the frequency and magnitudes of extreme flood events.

3. Results

3.1. Development of the regional landscape

The boreholes can be divided into two groups: those dominated by long (up to 10 m) sequences of relatively homogeneous dark brown-grey silty clays; and those in which only a few metres of similar fines cover sandy deposits further down (Fig. 3). The first group is the result of overbank deposition during regular floods that conveyed fine sediments onto the floodplains. The alluvial fines are underlain by a sandy substrate, consistently found throughout the region (Fig. 5A), which is assumed to have accumulated in a significantly different fluvial setting with more turbulent flows and a braided channel style (Adamson et al., 1980; Said, 1993; Butzer, 1998). At several locations, ceramics of a Middle to New Kingdom age are found just above this substrate (Fig. 5A), so a rough pre-New Kingdom date can be assigned to the top of this regional substrate. A single location with many Middle Kingdom to Second Intermediate Period ceramics is situated directly to the front (southeast) of Kom el-Hettân (Fig. 5A). As the ceramic assemblage at that level also includes New Kingdom ceramics, the occurrence of older material probably relates to the dumping of cultural material, perhaps when the area was cleared for temple construction. The level of the regional substrate varies, with its lowest elevations (< 66 m + msl; above mean sea level) to the south of Kom el-Hettân. This depression is filled with very fine-grained and slightly organic silty clays, which suggests that the fringe of the valley would have been a low-lying marshland. This fits with a negative floodplain relief that can occur in large river valleys (Lewin and Ashworth, 2014), and the suggestion by Kemp and O'Connor (1974) that the large artificial basin of Birket Habu (c. 1 km to the southwest; Fig. 1) may have been created in a pre-existing natural low-lying part of the regional landscape.

For most floodbasin cores, New Kingdom and Roman palaeo-surface levels were identified by the dating of ceramics at various depths (Table 4). New Kingdom-dated ceramics are generally concentrated in two levels; between 68 and 70 m and around 71–72 m + msl. Whenever both are locally present in a floodbasin core, the levels usually are separated by 1–3 m of Nile clays (Fig. 3D). In a few places, the lower New Kingdom zone features blue-painted ware as well as Marl B ceramics (Fig. 4). Blue-painted ware is particularly distinctive of the mid- to late 18th Dynasty and had a short period of occurrence: its production started under the reign of Thutmose IV (1400–1390 BCE) and was discontinued shortly after the reign of Ramsesses IV (1156–1150 BCE) (Hope, 1982, 1991, 2001; Aston, 1998). Marl B is a fabric that occurred between the Second Intermediate Period and the 19th Dynasty with its peak of use in the early to mid-18th Dynasty (Fig. 4) (Rose, 2007; Aston et al., 2008). Based on the principle of chronological superposition

Table 2
Levels (+ msl) of extreme floods in the Theban region with the level corrected to Kom el-Hettân (dates using Hornung et al., 2006).

Site	Reign and date	Level	Corrected level	Reference
Karnak (*New Kingdom temple floor flooded*)	Thutmose III (1479–1425 BCE)	> 74 m	> 74.05 m	Traunecker, 1971; Seidlmayer, 2001
Medinat Habu (*marker on western tribune*)	Ramesses IX, year 7 (c. 1122 BCE)	74.87 m	74.8 m	Hölscher, 1951
Karnak (*marker on western tribune*)	Shoshenq I, year 6 (c. 937 BCE)	74.0 m	74.1 m	Legrain, 1896; Seidlmayer, 2001
Karnak (*marker on western tribune*)	Osorkon II (c. 845 BCE)	74.2 m	74.3 m	
Karnak (*marker on western tribune*)	Osorkon III (c. 790 BCE)	74.35 m	74.5 m	
Karnak (*marker on western tribune*)	Taharqo, year 6 (c. 684 BCE)	74.4 m	74.5 m	

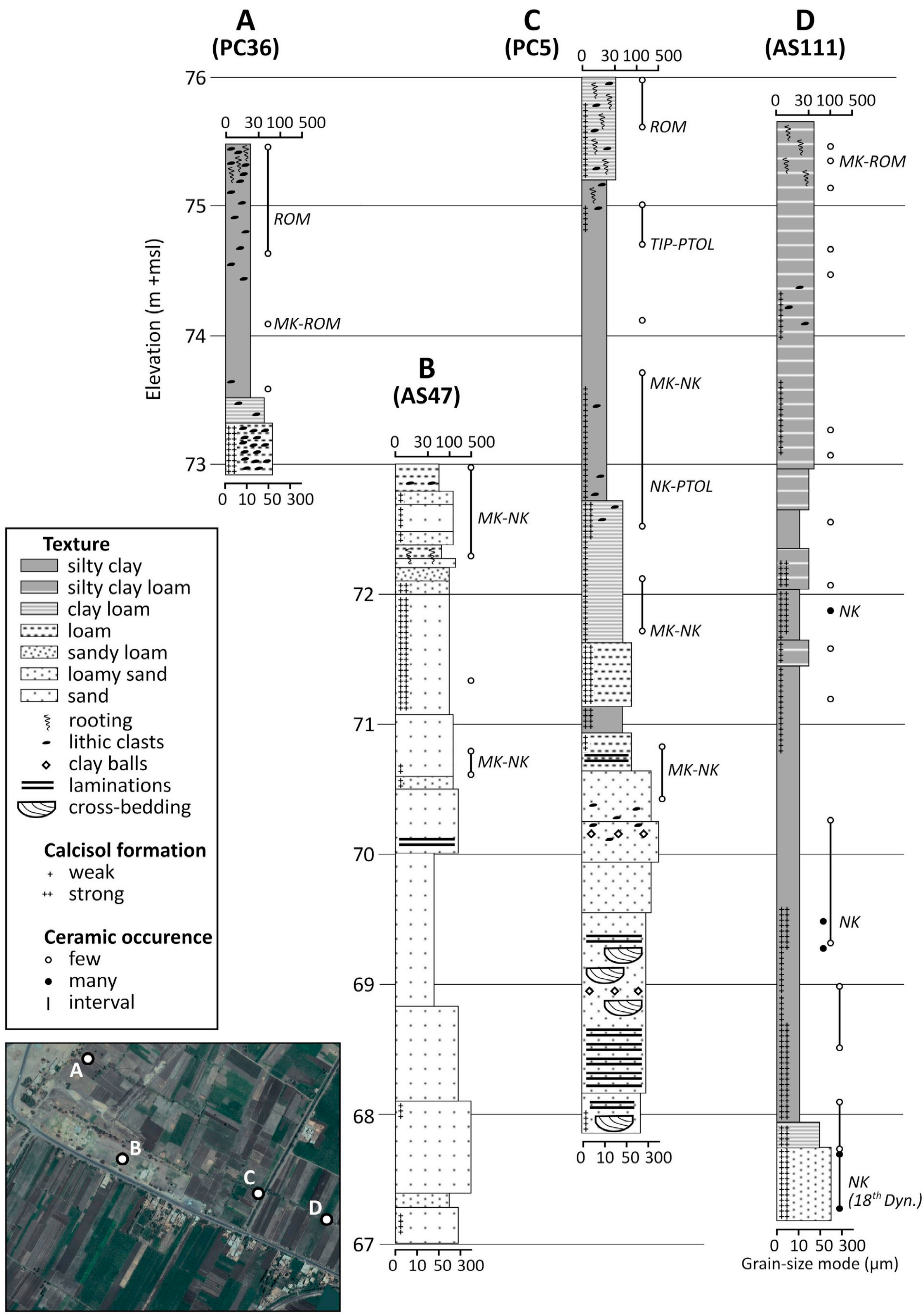

Fig. 3. Typostratigraphic boreholes; (A: PC36) desert edge with wadi deposits overlain by floodplain silty clays, (B: AS47) shallow sands underlying Kom el-Hettân (borehole in excavation pit), (C: PC5) sandy channel belt, (D: AS111) fine-grained floodbasin. Abbreviations: MK = Middle Kingdom; NK = New Kingdom; TIP = Third Intermediate Period; Ptol = Macedonian and Ptolemaic Period; Rom = Roman Period. The locations of boreholes A-D are also indicated on Fig. 2.

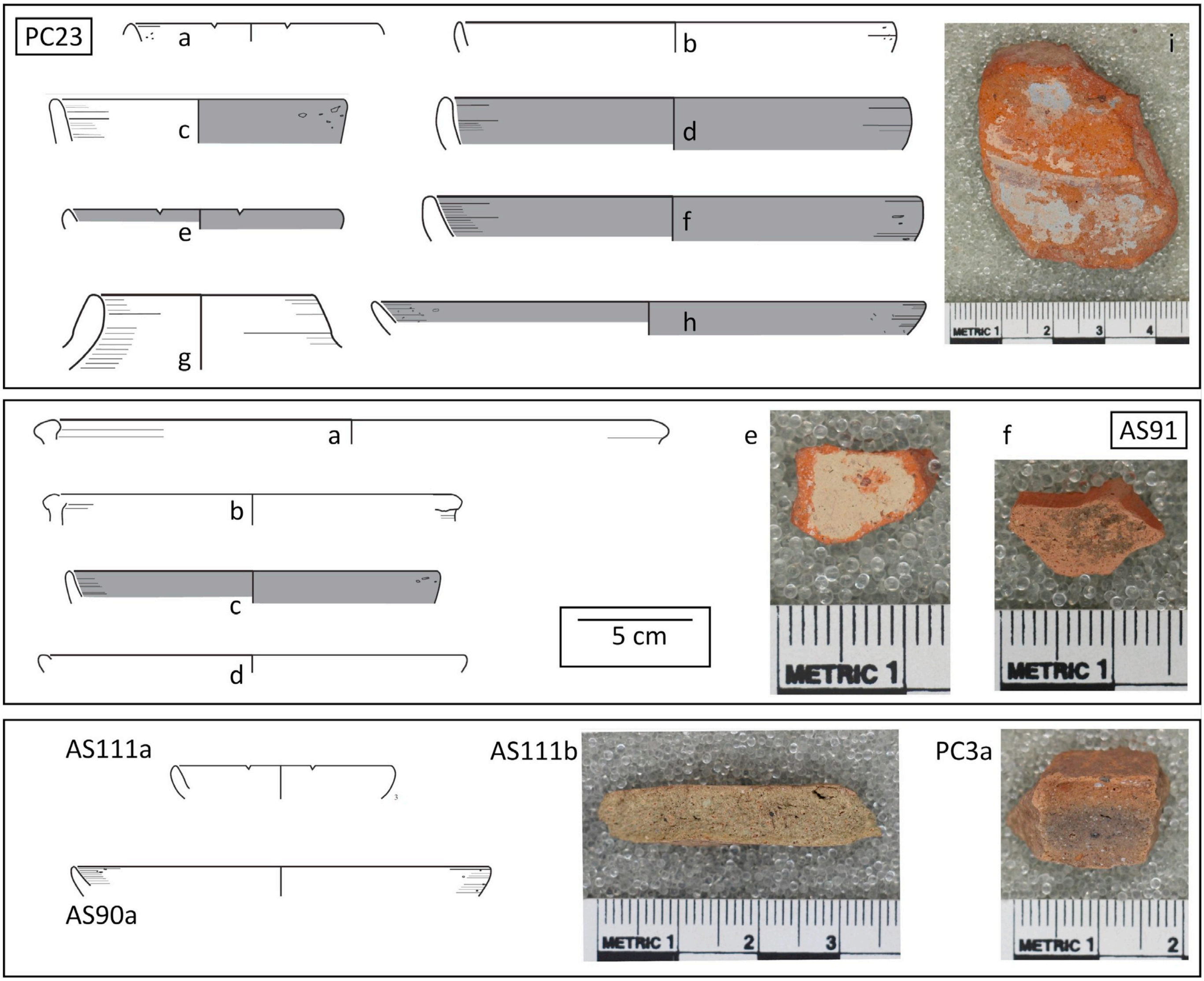

Fig. 4. Selection of diagnostic ceramic fragments - for the locations of the boreholes, see Fig. 2. For most reconstructed vessels, the orientation and exact diameter is uncertain. Specific pottery type (according to the Karnak system; see Supplement), inferred dates, and approximate depth of occurrence: PC23 - (a) P1, NK-LP, 600 cm; (b) P1, MK-NK, 610 cm; (c-f) P1, MK-NK, 620-630 cm; (g) P9, NK-TIP, 640 cm; (h) P1, MK-NK, 640 cm; (i) P9 (blue-painted ware), NK, 630 cm. AS91 - (a-b) P1, MK-NK, 420 cm; (c) P1, MK-NK, 540 cm; (d) P1, MK-NK, 600 cm; (e) C12a (Marl C in Vienna system), MK-SIP, 490 cm; (f) A (Aswan red slip ware), Rom, 650 cm (probably down-borehole contamination from higher levels). AS90a - P1, MK-NK, 470 cm. AS111- (a) P1/P11, NK, 600 cm; (b) P37 (Marl B in Vienna system), SIP-NK, 810 cm (image showing reference specimen from Karnak). PC3a - P36 (Canaanite import), NK, 240 cm. Period abbreviations: MK (Middle Kingdom); SIP (Second Intermediate Period); NK (New Kingdom); TIP (Third Intermediate Period); LP (Late Period); Rom (Roman Period).

(Harris, 1989), it is generally assumed that where two New Kingdom-dated levels exist, the lower level relates to the earlier part of the New Kingdom (18th Dynasty), while the upper zone relates to the later part of the New Kingdom or the beginning of the Third Intermediate Period (20th-21st Dynasty: on the difficulty to distinguish late New Kingdom ceramics from Early Third Intermediate Period ones, see Aston, 1996).

In the second group of boreholes, i.e. non-floodbasin cores, sands are found at relatively shallow depths near the desert edge, below Kom el-Hettân and in a narrow zone to the east of Kom el-Hettân. The boreholes near the desert edge reveal its eastern extension in the subsurface. In ancient times the sandy and gravelly colluvium and wadi deposits of the desert reached further to the east. Over time the lower parts of the desert edge gradually became covered by the aggrading Nile floodplain. The difference of c. 150 m in position between the New Kingdom and modern desert edges (Fig. 5B), indicates that on the West Bank the lush Nile valley has not expanded much during the last three millennia.

Nearly all boreholes on and surrounding the central axis of Kom el-Hettân, and the boreholes within the northern part of the temple enclosure, feature sandy deposits at much shallower depths than in the surrounding area. Particularly along the main temple axis, sands are generally found at 71–72 m + msl, which is at least 4 m above the level of the regional substrate. Ceramics of New Kingdom age are locally only found above 71.5 m + msl (Fig. 6); below this level, only a single (undated) flint tool was encountered in the subsurface of the Second Court. To the front of the Peristyle Court (Fig. 2; Fig. 5A), three radiocarbon dates from the top of the sandy deposits provided an age between 2290 and 1870 BCE (Table 3; Karakhanyan et al., 2010). This suggests that a relatively high sandy feature existed contemporaneously with the low-lying marshlands at the level of the regional substrate. This high location would have provided a relatively safe place with regard to flooding (Section 3.3). During the flood season, its resemblance to the primeval mound of the creation myth, where the orderly world emerged from the 'Waters of Chaos' (Bryan, 1992; O'Connor,

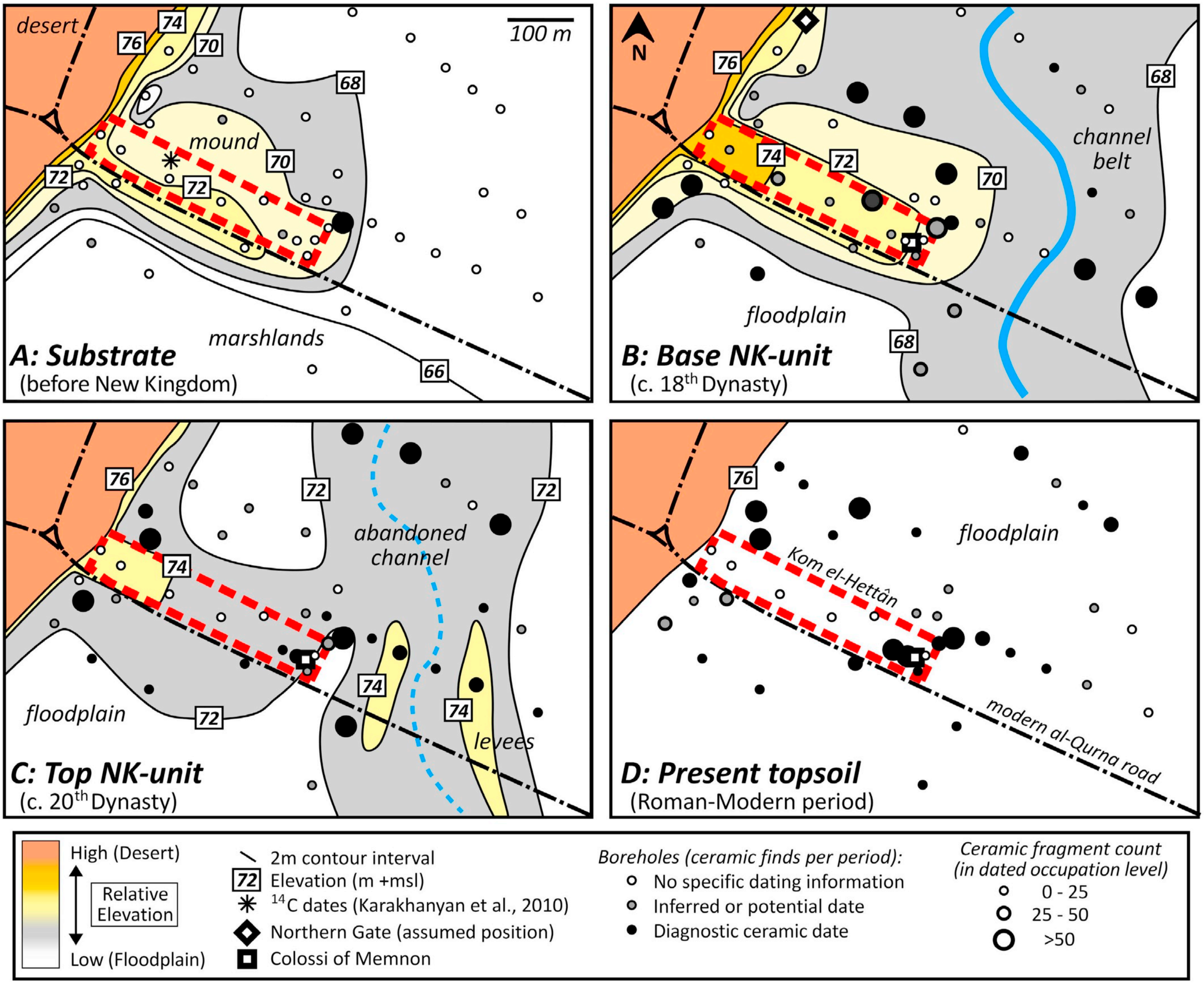

Fig. 5. Palaeogeographic reconstruction of the local ancient landscape around Kom el-Hettân - the present archaeological area of the main temple axis is marked with the dashed red line. NK = New Kingdom.

1998), would have made it a highly symbolic place for the ancient Egyptians.

The sandy feature underlying the temple has a particular shape with a NW-SE oriented crest that is highest close to the desert edge and slopes down towards the SE (Fig. 6). To the sides of the highest grounds, a steep slope exists to the south and a gentler slope to the north (Fig. 5A). The top few metres consist of well-sorted, relatively fine-grained (c. 150 μm) yellowish quartz-rich sands (Fig. 3C). Near the desert edge, and at larger depths, some wedges of medium to coarse sands (300–500 μm) were found (Fig. 3; Fig. 6). Similar deposits in texture, sorting, and colour have been observed in cut-banks at the downstream ends of local wadi channels (personal observations only; no detailed study permitted outside our concession). The downward sloping and fining of the sands towards the SE, away from the desert edge, the general configuration of the deposits, and the similarity with local wadi sediments suggest that the sands that underlie the temple were derived from a local wadi system and were washed into the floodplain. The distribution of sands to the north of the temple's main axis has the appearance of a wadi tributary fan (Fig. 5A); the connecting wadi most likely originated from the Valley of the Queens (Figs. 1 and 2) - although its course is difficult to trace due to heavy human disturbance in ancient and modern times. The steep southern slope and high crest seem slightly atypical for wadi tributary fan geomorphology (Butzer and Hansen, 1968). As a cause for this, human landscaping with removal of sediment from the southwest and dumping of it at the location of the temple axis cannot be ruled out, considering such projects were conducted at nearby Birket Habu (Kemp and O'Connor, 1974).

The research area is shielded by the Theban limestone plateau from major aeolian input by draa sand dune migration. No mobile sand dunes are present on the surface of the plateau or on the calcified surface of the local desert. Archaeological sites on the western desert edge are also buried by colluvium, and not by aeolian sands. Hence, while stabilised sand dunes have been observed elsewhere in the Nile Valley, with the closest example near Armant at c. 12 km SW of Kom el-Hettân (Vermeersch and van Neer, 2015), this seems an unlikely origin for the geomorphological feature on which Kom el-Hettân was founded.

The third location where sands are encountered at levels significantly higher than the level of the regional substrate is to the east of Kom el-Hettân. Starting c. 100 m east of the Colossi at the front of the temple, sandy deposits occur locally at c. 71 m + msl (Fig. 6). These sands are different from those in the subsurface of the temple by having a light brown-grey colour, being generally coarser (median grain-size of max. 350 μm) and containing distinct cross-bedded features (Fig. 3C). They are laterally not connected to the wadi tributary fan sands of Kom

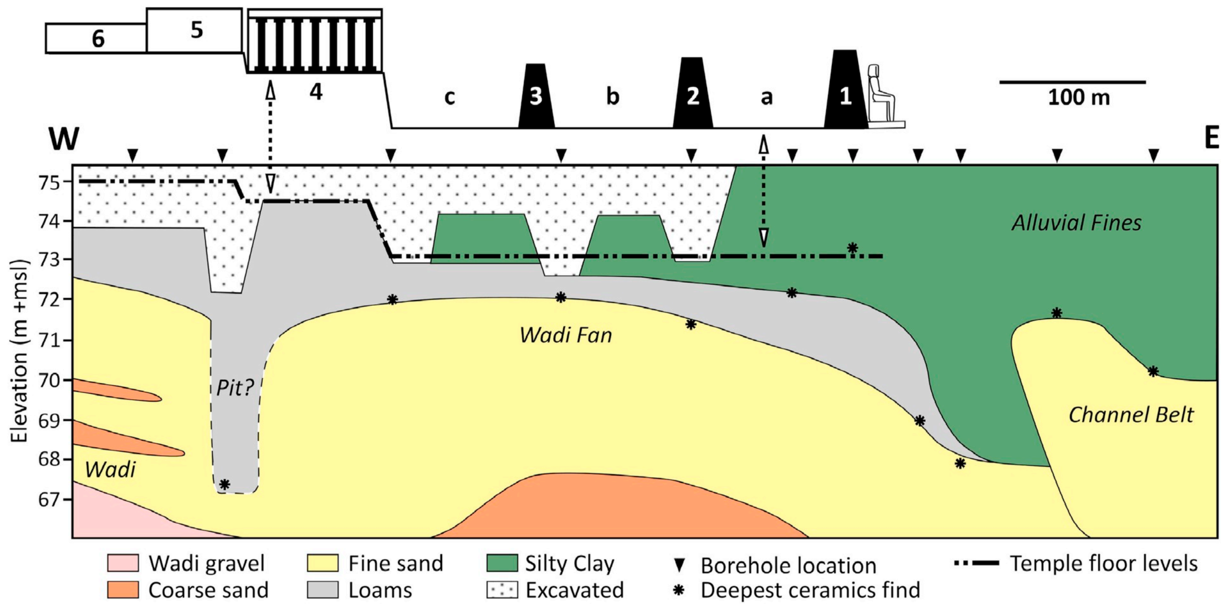

Fig. 6. Schematic lithological cross-section of the subsurface of Kom el-Hettân. The temple sections are shown at the top of the diagram. Numbering of the building features is according to Fig. 2; the height of architectural features is not to scale. The New Kingdom temple floor levels are derived from excavation reports (Sourouzian et al., 2006, 2011).

Table 3
Radiocarbon dates from Karakhanyan et al. (2010), collected from a trench located to the northeast of the Peristyle Court (location in Fig. 5A). Dates were analysed in 2008 by the IFAO (French Institute of Oriental Archaeology) in Cairo, Egypt.

Sample ID	Material	2σ age range
1	Charcoal	2144–1866 BCE
2	Charcoal	2231–1882 BCE
15	Clay	2287–1901 BCE

el-Hettân, but are separated from it by a thick sequence of floodplain clays (Fig. 6). The sedimentary characteristics suggest that these sands were transported by active river flow, carrying relatively coarse particles as bedload at the base of a river channel. A river channel thus occupied the valley to the eastern front of Kom el-Hettân, connecting in a downstream direction with the New Kingdom-dated channel to the front of the Ramesseum (Fig. 2) (Toonen et al., 2018). Based on the width of the sand body, the channel belt was 250–400 m across. This further agrees with the observations made near the Ramesseum to the north of Kom el-Hettân. Dating information from ceramic finds on top of the sands and loams that represent the levees, suggests this channel system was active into the late New Kingdom period. If the channel was in existence during the early New Kingdom, it likely would have played an important role in the construction of Amenhotep's royal cult temple by providing easy access to the site by boat, allowing building blocks and colossal monolithic statues to be delivered very close to the site. Moreover, such direct access to the site would also have played an important role in the interconnected ritual landscape of Thebes, with New Kingdom festivals of Amun that included processions that crossed the valley by ceremonial barge (Johnson, 1998; O'Connor, 1998), thus enabling direct travel between sacred localities in the valley axis (i.e. Karnak and Luxor Temple; Fig. 1) and the royal cult temples of Western Thebes.

The reconstruction of changing landscapes based on the alluvial architecture of the subsurface demonstrates that the regional landscape evolved from a sandy braided river plain into a marshy backswamp area dominated by silty clays that were deposited as overbank material. Above this low-lying environment stood the wadi tributary fan on which Amenhotep III's Mansion of Millions of Years was established. At that time, a minor river channel was (or came) in existence, which built levees that gradually rose above the surrounding landscape. At the end of the New Kingdom, the river channel was abandoned (Fig. 5C). In the last three millennia, all pre-existing geomorphological features were successively covered by aggrading overbank sediments (Fig. 5D).

3.2. Temple configuration and focal areas of cultural activity

From the borehole information it becomes clear that the central axis of the temple was founded on the highest part of the pre-existing wadi fan. The high grounds extended towards the southeast below the Colossi of Memnon (Fig. 5; Fig. 6) and the statues are positioned exactly where the sands started to slope down. This suggests that they could have been placed with an eye towards the natural topography in order to create an even more imposing temple façade, using the step in the terrain to enhance the already impressive height of the statues. A distinctive layer of mixed deposits, consisting of loams with abundant ceramics, overlies the top of the natural wadi fan deposits and forms the foundation of the statue's pedestals (Fig. 6). Similar mixed deposits are found in all cores along the temple axis between the top of the sandy deposits and the temple floor levels, suggesting anthropogenic raising and levelling of the surface to the level of 73 m + msl (Fig. 6). The back of the temple, from the Peristyle Court to the Sanctuary (Fig. 5B; Fig. 6), was raised further to 75 m + msl to create the traditional stepped temple appearance (Wilkinson, 2000).

In an excavation pit at the back of the temple, where a main temple wall between the Peristyle Court and Hypostyle Hall is reconstructed (Fig. 6) (Sourouzian, 2017), a c. 4 m thick sequence of loams was encountered. Locally, multiple Sekhmet statues were excavated from below the original temple floor levels. The statues have been dated to the reign of Amenhotep III (Sourouzian, 2017). Middle to New Kingdom-dated ceramics occur throughout the deposits but lack any chronostratigraphic succession and are mixed with numerous small sandstone chips - suggesting that these deposits are strongly anthropogenically affected. The deposits are probably a result of the organised destruction of the temple; as infill of a pit that was formed when the temple wall was robbed out (Sourouzian, 2017).

During the New Kingdom (and before), a particularly steep gradient was present towards the southern part of the temple enclosure, which would have been low and marshy. In comparison, the northern part of the temple enclosure was relatively high and is characterised by the frequent occurrence of ceramics, degraded mudbrick fragments, and sub-cm pieces of sandstone. Such finds are largely absent in the boreholes to the south of Kom el-Hettân. Although no direct evidence for monumental buildings was found in either zone, the ceramic finds in the north suggest a more active use during the New Kingdom (Fig. 5B) - albeit still very minor compared to the main axis of the temple based on the ceramic counts (Supplement). Due to the relatively small and often abraded nature of ceramic fragments it was not possible to deduce any specific type of activity.

The northern part of the temple enclosure is also where one of the access routes to the temple has been reconstructed, based on the attested location of the Northern Gate, where the remains of two colossal statues were found (Fig. 5B). Our reconstruction indicates that the gate was positioned on the lower part of the desert edge. Floodplain aggradation caused submergence of this surface level during the later part of the New Kingdom to Third Intermediate Period (Fig. 5C). In broadly the same period, cultural activity became more focussed on the minor Nile channel (Fig. 5C), whose relatively high levees provided protection against regular floods. The number of ceramic finds decreases after the New Kingdom, suggesting a submergence of the entire regional palaeotopography. In this post-New Kingdom floodplain environment, relatively little archaeological material is found, except for Roman to modern ceramics in the upper 1.5 m of the subsurface. Ceramics of Roman and Late Roman age are notably clustered along the desert edge and around the Colossi of Memnon (Fig. 5D).

3.3. Floodplain aggradation and flooding of the temple

Markers on ancient structures in the Theban region show that at least 6 flood events exceeded 74 m + msl during the New Kingdom and Third Intermediate Period (Table 2) and would thus have flooded the Courts of Amenhotep III's royal cult temple with their floor levels at c. 73 m + msl (Fig. 7). The completeness of extreme flood registration at Thebes is unknown. Several large floods may have occurred but left unrecorded, or their records may not have been preserved or discovered yet. Well-dated sedimentary records from the Desert Nile at Amara West and Dongola in Sudan (Macklin et al., 2013; Woodward et al., 2017), identified major flood events at similar times as the ones referred to in this study. From this we, tentatively, assume that the Theban record may be a fair representation of large Nile flood occurrence in the studied period. Of the regionally recorded events, probably only the Ramesses IX flood would have inundated the higher rear part of the temple, and then only marginally. The flood during the reign of Thutmose III predates the construction of the temple and would have inundated the top of the wadi fan deposits, with 2 m of water standing above it. Therefore, it seems likely that the possibility of flooding at the site was known when construction of the temple commenced.

Whilst the temple would have been constructed to accord with the architectural symbolism of New Kingdom temples (Wilkinson, 2000), it remains unclear if the 73 m level of the Court floors was deliberately chosen with understanding of past floods. This would mean that the Courts flooded occasionally whilst the Sanctuary remained dry. This would produce not just the symbolism in architectural form, where the Courts reflect the low annually flooded marshlands and the Sanctuary the primeval mound standing above the flood waters (Wilkinson, 2000), but also in reality. The presence of mudbrick structures in the lower parts of the complex seems, however, at odds with this design to be frequently inundated, given the vulnerability of mudbricks to flood waters.

Floodplain aggradation progressively caused an increased frequency of temple floor inundation as it allowed regular floods to reach higher absolute elevations over time. During the New Kingdom, approximately 3 m of floodbasin aggradation occurred locally, with surface levels reaching up to c. 72 m + msl at the end of the New Kingdom (Table 4). Karakhanyan et al. (2010) place the onset of widespread silt accumulation at the temple Courts in the same period, around 1100 BCE. Karnak flood markers similarly show that the 73 m + msl level was regularly reached between 940 and 780 BCE (Seidlmayer, 2001). Hence, floods of moderate magnitude, on average occurring every 5 years, started to reach the temple regularly at the end of the New Kingdom, and continued to do so during the Third Intermediate Period.

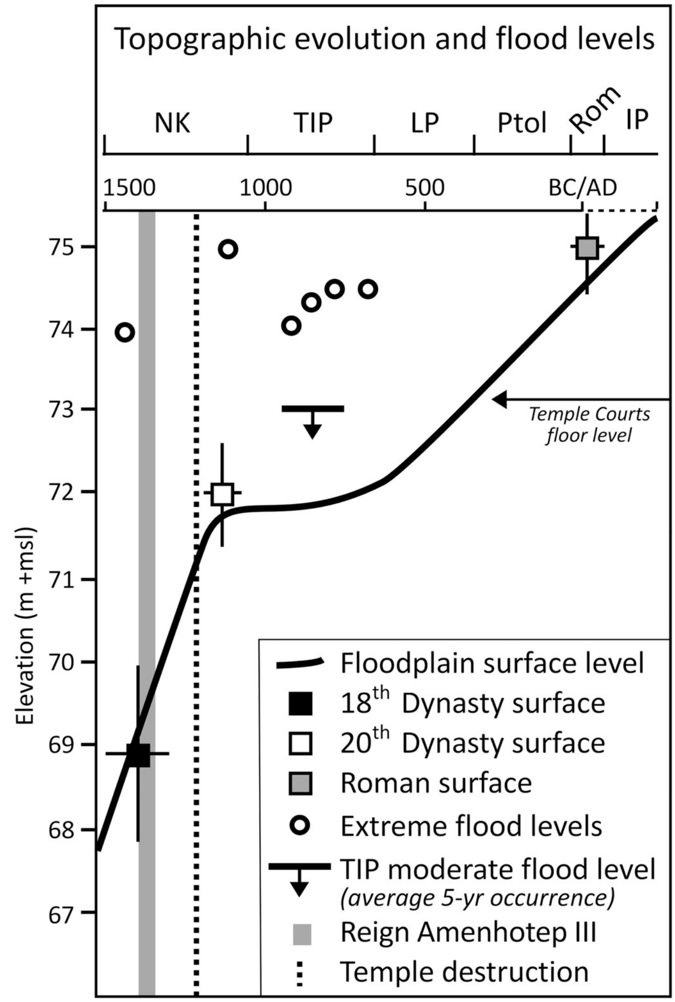

Fig. 7. Reconstructed floodplain aggradation, based on dated ceramics in floodbasin cores. The uncertainty margins of inferred 18th Dynasty (i.e. bottom New Kingdom ceramic occurrence), 20th Dynasty (i.e. top New Kingdom ceramic occurrence), and Roman levels represent the spread of data around their average level of occurrence in floodbasin cores (Table 4). The Third Intermediate Period average flood level for moderately-sized events (associated 5-yr recurrence time) is assumed to roughly match a c. 1 m regular flood depth (following Butzer, 1976; Seidlmayer, 2001). Abbreviations: NK = New Kingdom; TIP = Third Intermediate Period; LP = Late Period; Ptol = Ptolemaic Period; Rom = Roman Period; IP = Islamic Period.

The reconstructed floodplain surface levels relate to accumulation rates of at least 6 mm/yr during the New Kingdom (Table 4; Fig. 7). Accumulation rates since the New Kingdom amount to 1 mm/yr on average, which is also a commonly used rate of regional floodplain deposition in the last two millennia (Ventre, 1896; Ball, 1939; Bunbury et al., 2008; Toonen et al., 2018). The secondary branch of the Nile that occupied the western margin of the valley during the New Kingdom is likely to have accelerated local deposition rates, primarily where it built its levees, but also in the adjacent floodbasin areas, which were still relatively proximate to this local source of sediment.

Fluctuations in sedimentation rates similar to our observations have

Table 4
Dated levels in twelve floodbasin cores (Fig. 2). Ages are inferred from ceramic assemblages (Supplement). *uncertain age assignment; usually with a wider dating range than strictly the New Kingdom period.

Core ID	Elevation (m + msl)		
	Substrate (top)	New Kingdom	Roman Period (base level)
AS91	68.0	68.2–71.6	75.0
AS102	67.9	68.4–72.6	75.0
AS103	66.0	68.6–70.4*	75.4
AS105	64.6	69.8–72.4	75.0
AS106	65.8	67.2–72.2	74.8
AS109	68.2	68.0–71.8	74.2
AS110	68.8	69.0–72.0	74.8
AS111	67.8	67.4–72.8	–
AS121	68.8	69.8–72.4	–
AS122	69.2	69.8–72.2	75.4
AS123	69.0	70.0–72.0*	75.4
AS124	67.8	69.4–72.2	74.8
Average (top/bottom)		68.9/72.1	75.0
Standard deviation		1.0/0.6	0.4

been recorded elsewhere in the Nile Valley. Seidlmayer (2001) reports an interval of anomalously high rates of deposition between 2000 and 1500 BCE throughout the Egyptian Nile Valley. This may have continued into the New Kingdom, based on frequent Nile flood deposition observed at various places in Sudan (Macklin et al., 2013; Woodward et al., 2017). Thereafter, during the Ramesside Period and continuing into the Third Intermediate Period, flood amplitudes diminished. In the Theban region, the decline in sedimentation rates is reflected in the widespread development of (weak) calcisols in the upper New Kingdom levels (Toonen et al., 2018). Review studies focussing on trends in Nile deposition (Said, 1993; Butzer, 2012; Macklin et al., 2015) show that overbank sediment accumulation peaked between 1350 and 1150 BCE, which is in accordance with our findings. After c. 1150 BCE, peak discharges may have declined and channel networks contracted (Macklin et al., 2015), leading to the abandonment of minor branches of the Nile. Nile branches, such as the one that was located to the front of Kom el-Hettân and the one immediately north of Amara West in Sudan (Woodward et al., 2017), became defunct around this time. Therefore, the local observations seem to fit in a regional framework of hydroclimatic change, which may have had a significant effect on the Egyptian riverine civilization. In general, the limited deposition of fertile Nile sediment by a reduction in flood activity has been suggested as a contributing factor to the attested political instability (Said, 1993; Butzer, 1984; van Dijk, 2000) and grain price fluctuations (Černý, 1954) at the end of the New Kingdom. On a local scale, the contraction of channel networks may have affected the desirability of settlement locations - as, for example, suggested for Amara West (Woodward et al., 2017).

Based on the reconstructed floodplain surface levels, frequent flooding is unlikely to have become a serious threat to the temple already within c. 140 years after its construction. Material from Kom el-Hettân was reused for the construction of a neighbouring temple complex during the reign of Merenptah. At that time, floodbasin levels would have risen to c. 71 m (Fig. 7). Flood stages would still have needed to exceed c. 2 m above the floodplain surface level to reach the Courts and 4 m to reach the Sanctuary. This would have been possible, as the Thutmose III, Ramesses IX and Third Intermediate Period floods show (Fig. 7), but would have occurred only rarely, and flooding depth would have been limited. Moderately-sized floods would only have reached a c. 1 m water depth on the floodplains (as estimated by Butzer, 1976; Seidlmayer, 2001), and would not have flooded the Courts. Although relatively high groundwater levels during the flood season may have caused degradation of foundations and structures, the destruction of the temple does not seem to have been primarily caused by floods. Karakhanyan et al. (2010) found deformation structures and sedimentary evidence for liquefaction in the top of the sandy deposits that underlie the temple. Radiocarbon dating of liquefaction features and the study of ceramics could date a large earthquake to the beginning of Merenptah's reign, around 1200 BCE (ibid.). Together with the comparable alignment of fallen statues throughout the temple (as observed by Karakhanyan et al., 2014), this points to a major earthquake as the main cause of destruction of Amenhotep III's royal cult temple.

4. Conclusion

From the palaeo-environmental reconstruction of the local landscape at and around Amenhotep III's Mansion of Millions of Years, it can be concluded that the temple was constructed on natural sandy deposits, at several metres above the contemporaneous floodplain. The relatively high grounds were most likely naturally formed as wadi tributary fan deposits derived from the Valley of the Queens wadi system. When surrounded by flood waters, the high grounds would have resembled the mythical primeval mound, and was probably therefore selected as an auspicious and symbolic location for building the royal cult temple of Amenhotep III. The mythological concept of rejuvenation might have been further enhanced by placing Court floor levels at elevations that were known to flood occasionally. The Colossi of Memnon stood at the imposing front of the high ground, overlooking a minor branch of the Nile directly to the east and marshlands to the north and south. A drop in the level of the terrain immediately to the front of the Colossi would have magnified the size of Amenhotep III's statues to people who arrived by boat. This strongly suggests an advanced utilisation and understanding of the regional landscape in ancient times, with a profound interconnected and synergetic functioning of natural, human, and ritual landscapes.

This study argues that floods would probably not have been the primary factor in the destruction of Amenhotep III's royal cult temple. The temple would have stood high and dry for most of its active use prior to its destruction. A rather anomalous period of high sediment accumulation rates at the start of the New Kingdom period, unparalleled in the last three millennia but synchronously observed in other historical and geological records, caused rapid aggradation of the regional landscape that surrounded the temple. As no natural sedimentation occurred on the top of the high temple grounds, the difference in elevation between the temple floors and the floodplain decreased gradually. Floods of moderate magnitude could have flooded the temple regularly at the end of the New Kingdom and during the Third Intermediate Period. At the attested period of temple destruction during the reign of Merenptah, regular floods were, however, still not very likely to have inundated the temple floors. It is therefore considered more likely that the temple's initial destruction came about as a result of a major earthquake, followed by organised dismantling of building blocks for reuse in nearby construction projects.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2019.03.003.

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