The Journal of Ancient Egyptian Architecture

2016 Volume 1

JAEA

www.egyptian-architecture.com

Please send manuscripts by email to
submission@egyptian-architecture.com

Guidelines for contributors:
http://www.egyptian-architecture.com/ressources/Formatting_Guidelines_for_JAEA_Contributors.pdf

ISSN 2472-999X

The Journal of

Ancient Egyptian Architecture

2016 Volume 1

Contents

JAEA 1, 2016, pp. 1-9 www.egyptian-architecture.com

The use of the ‘ceremonial’ cubit rod as a measuring tool
An explanation

Fr. Monnier, J.-P. Petit & Chr. Tardy

The so-called[1] ceremonial cubits, the majority of them fragmented and incomplete, incorporate a remarkable quantity of technical inscriptions given their compact dimensions.[2] While it has been established that the texts are mostly of a religious nature with an apotropaic character, information about timekeeping and distance measurements collected on them clearly reveal another more technical role as *vade-mecum* and official standard.[3] In spite of that evidence, previous studies have not yielded a full understanding of the inscriptions which are engraved on these singular objects.

In the first instance, this article reviews the types of inscriptions that are usually found on these artefacts. In the second instance, we set out to demonstrate that the inscribed subdivisions which divide these ‘ceremonial’ cubits into submultiples of a finger, have the property of allowing this kind of instrument to serve as a graduated ruler. This could have been helpful for producing architectural drawings and carrying out artisanal projects requiring a high level of precision, for example when creating high quality decoration or statuary.[4]

Description of a ‘ceremonial’ cubit rod

The oldest examples of the so-called ceremonial cubits date back to the New Kingdom.[5] In addition to their symbolism they are distinguished from the more common cubit rods by the prestigious material utilized for their manufacture; stone or metal (wood is more rarely used),[6] and by the wealth of texts and information that would appear to have been superfluous for ordinary measuring tools (see below).

Fig. 1. Maya’s cubit (18th Dyn., Louvre Museum, N 1538)
(photo courtesy of Alain Guilleux).

1. We gratefully acknowledge Alain Guilleux for providing the photos for the article, and David Ian Lightbody for proof-reading the english text.

2. Readers should refer to Lepsius (1865); Petrie (1926), pp. 38-42, pl. XXIV-XXV; Scott (1942); Schlott-Schwab (1981); Clagett (1999), pp. 9-15, fig. IV.24-IV27e; Zivie (1972); Zivie (1977a); Zivie (1977b); Zivie (1979).
3. Zivie (1979), p. 343.
4. Arnold (1991), pp. 251-252.
5. Maya’s cubit rod (18th Dyn., Louvre N 1538) and Amenemope’s cubit rod (18th Dyn., Turin no. 6347) (Saint John (2000)).
6. Maya’s cubit rod (18th Dyn., Louvre N 1538) and Any’s cubit rod (20th Dyn., Liverpool Museum 03/061/4424).

When accurately made, they employ a sleek section in the form of a long parallelepiped rectangle and are 0.523 m long. This is the exact length of a royal cubit (*mḥ nswt*).[7] The section has a chamfered top edge, and with the inclusion of the ends this results in a total of seven faces, which will be referred to using the letters from A to F, according to the nomenclature established by Adelheid Schlott-Schwab.[8] The carved inscriptions on these objects can be summarized in five main groups.

The graduation/subdivisions

The graduations and associated metrical nomenclature are the most regularly reproduced information on all of the cubit rods. These rods adopt a digital system which consists of dividing the royal cubit into 28 fingers and multiples of fingers.[9] The multiples include the palm (4 fingers), the hand's breath (5 fingers), the fist (6 fingers), the double palm (8 fingers), the small span (12 fingers), the great span (14 fingers), the sacred cubit (16 fingers), the remen cubit (20 fingers), the small cubit (24 fingers) and the royal or pharaonic cubit (28 fingers).[10] Finally, the last fifteen fingers of the graduated part are further subdivided successively into 2, 3, 4, 5, ..., 14, and 16 equal parts. All the subdivisions are finely cut and emphasized with white paint, and are superscripted by their unit fractions written in hieroglyphs.

The submultiples of a finger given in the last fifteen sections are all displayed with their measurements expressed as parts of a finger : *r*(*ꜣ*)-2, *r*(*ꜣ*)-3, *r*(*ꜣ*)-4, *r*(*ꜣ*)-5, ..., *r*(*ꜣ*)-15, *r*(*ꜣ*)-16, which are usually translated in our modern language into fractions : 1/2, 1/3, 1/4, 1/5, ..., 1/15, 1/16.[11]

The calibration table of the setjat[12] (*sṯꜣt*)

The setjat (or aroura in Ancient Greek) is an area measurement, the unit of which is equivalent to a square of 100 royal cubits per side, that is to say 10,000 square cubits.[13]

Although for reasons still not understood, this standard was adopted all over Egypt, but with slightly fluctuating values from one nome to another.[14] It was subsequently necessary to define a variable for each nome allowing adjustment for[15] the 100 cubits side involved in the calculation of this surface area. This is one of the parameters that is incorporated on the ceremonial cubit rods. This was occasionally used during the New Kingdom, but more commonly after the Third Intermediate Period. It is important to note, however, that this system was in use far earlier, given that this table is depicted on the walls of the white chapel of Senwosret I at Karnak.[16]

This corrective value was indicated for the 22 nomes of Upper Egypt and 17 nomes of Lower Egypt, usually on faces A and B, but also on face E. Each nome is usually superscripted by the name of its protecting god. In the oldest known copies, the names of the gods stand alone, sometimes even without any reference to the setjat.[17]

---

7. or 'great cubit' (Carlotti (1995), p. 129).
8. Schlott (1969), p. 43.
9. Carlotti (1995), p. 129.
10. Carlotti (1995), pp. 129-131.
11. Michel (2014), p. 74.
12. Lacau and Chevrier (1956), pp. 216-217; Schlott-Schwab (1981), p. 32; Graefe (1973).
13. Michel (2014), pp. 129-132.
14. Graefe (1973); Zivie (1979), pp. 335-336.
15. In all cases, the adjustment was carried out by a subtraction. The 100 cubits value represents an upper limit for the calculation of the setjat.
16. Lacau and Chevrier (1956), pp. 216-217.
17. Saint John (2000), p. 2.

Fig. 2. Ceremonial cubit of Osorkon II (Cairo Museum, RT 31/12/22/2)
(photo courtesy of Alain Guilleux).

Chronometric tables

All the cubit rods dating to the Late Period incorporated substantial tables recording measurements in connection with the hours of the day, on their face D. The Ancient Egyptians divided daylight and nighttime into two equal parts, 12 hours each, regardless of the time of the year.[18]

This fixed division had the disadvantage of requiring a decrease in the length of the hours of daylight during the 6 months around winter time, and an increase during the 6 months around summer. The instruments they used for accurate timekeeping, the clepsydra and the gnomon, therefore had to be calibrated periodically to take account of this annual evolution.[19] Two tables refer to this practice. The first one gives a volume indication for each of the twelve months of the year, each one being preceded by the mention 'hour of the water which is the *ʿnḏ*-vase (clepsydra)' (*wnw.t mw ḥr*(*y*)*.t-jb ʿnḏ*).[20] The second table specifies length measurements for the three decades (10 day period) of each month of the year. Its annotation 'darkness ("shadow" ?) which is in the hour of day' (*grḥ ḥr*(*y*)*.t-jb wnw.t ḥrw*) seems to refer to some type of shadow clock; a gnomon or sundial.[21]

Topographical distances

Given in iteru (*jtrw*, approximately 10.46 km in length), these measurements are restricted to the dimensions considered to be distinctive characteristics of Egypt; a total of 106 *jtrw*: 86 between Elephantine and *Pr-jʿpy*, and 20 between *Pr-jʿpy* and the *pḥw* of *Bḥd.t*.[22]

The meaning and operation of another succession of measurements preceded by the mention of an iteru has not yet been resolved.[23]

Dedications and eulogia

The faces D, E, and lateral faces could be inscribed with royal protocols, and dedications were made to the pharaoh or by a pharaoh to an individual (see below). This was particularly common during the late periods with formulas indicating their ritual purpose and their religious context.[24]

18. von Bomhard (1999), pp. 66-69.
19. Borchardt (1920); Clagett (1995), pp. 48-165; von Bomhard (1999), p. 66 (n. 26-28).
20. Schlott-Schwab (1981), p. 44.
21. Schlott-Schwab (1981), p. 45.
22. Schlott-Schwab (1981), p. 49; Schlott-Schwab (1972), pp. 109-110. Data which are collected on the walls of the white chapel at Karnak (Lacau and Chevrier (1956), pp. 242-243).
23. Schlott-Schwab (1981), p. 50. These measurements are also replicated on the white chapel at Karnak (Lacau and Chevrier (1956), pp. 246-247).
24. Schlott-Schwab (1981), pp. 53-63.

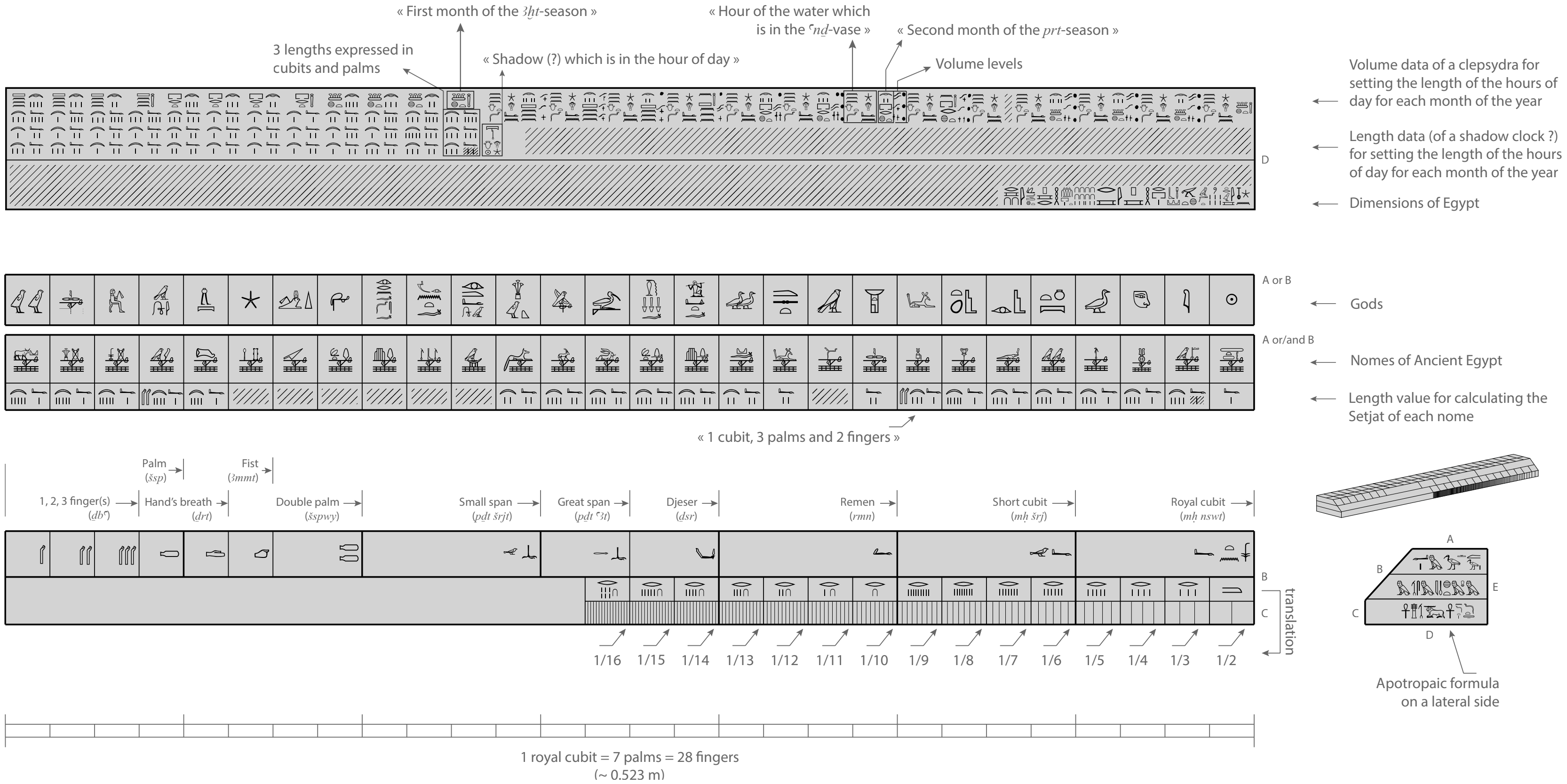


Fig. 3. Traditional data on a late ceremonial cubit rod. Scale: 1/3.
(after Gabra (1969), fig. 2; Zivie (1972), pl. XLIV; Saint John (2000); Schwab-Schlott (1972), taf. XXIV-XXVI; setjat values after Lacau and Chevrier (1956), pls. 3, 40, 42)

The annotations also reveal their apotropaic value: 'Cubit as life, strength, health, as a protection that repels the enemy (...)' (*mḥ m ʿnḫ, wḏꜣ, snb m sꜣ ḫsf sbj*).[25]

Nature of the 'ceremonial' cubit rod

The information immediately above clearly indicates that these objects were not primarily utilitarian, but ceremonial. Some models recovered from private tombs also show that they could be provided as honorary awards; a distinguishing offering to some particularly deserving craftsman or architect. In that case the boon is addressed to the gods, like an intercession in favor of the recipient, such as in the dedication on the wooden cubit rod discovered in the tomb of Any, a craftsman of Deir el-Medineh:[26]

ḥtp dj nsw jmn-rʿ ptḥ nsw tꜣwy ḏḥwty nb mdw-nṯr nṯr ʿꜣ ḥr(y)-jb wnw dj.sn ʿnḫ wḏꜣ snb ʿḥʿ.w nfr ḥr šms kꜣ.sn n kꜣ n sḏm-ʿš m st-mꜣʿt ꜣny

'A boon which the king gives (to) Amun-Re and (to) Ptah, lord of the two lands, and (to) Thoth, lord of divine words, great god who dwells in Hermopolis, that they may give life, prosperity and health, and a good lifespan, following their ka's, for the ka of the servant in the place of truth, Any.'

A similar inscription is found on one offered by Horemheb to Amenemope (Turin Museum, no. 6347):

ḥtp dj nsw nṯrw nbw mḥ-nsw dj.sn ʿḥʿw nfr m ʿnḫ tp tꜣ

'An offering that the king gives to all the gods of the royal cubit so that they may give a perfect span of life upon earth (...).'[27]

This symbolic aspect cannot overshadow the origin and the significance of the usual information that is found on these miniature monuments. Mostly they are of a technical nature, and all of them are related to spatial and chronological measurement.

The hieroglyphic texts of the temple of Edfu refer to the cubit by calling it 'cubit of Thoth',[28] or 'cubit of establishing Maat'.[29] One text indicates that the god Thoth was considered to be the 'lord of the cubit'.[30] On certain specimens, this cubit is called the 'cubit of accuracy',[31] or 'being in accordance with the writings of Thoth'.[32] As Thoth is the god of writing, arts and technical skill,[33] the lord of scribes, and the one who makes measurements,[34] everything suggests that this instrument

25. Zivie (1972), p. 188.
26. Liverpool Museum 03/061/4424 (http://www.globalegyptianmuseum.org/detail.aspx?id=4424 [date accessed : 11 june 2016]).
27. Lightbody (2008), fig. 8, p. 6 (translation by Angela McDonald).
28. Edfou VI, 7, 2-3.
29. Edfou VII, 126, 15 et 127, 7.
30. Edfou V, 91, 2.
31. *mḥ tp-ḥsb* (Gabra (1969), p. 130).
32. Schlott- Schwab (1981), pp. 46-47. See also Zivie (1977a), p. 34.
33. Boylan (1922).
34. Zivie (1977a), p. 26; Hart (2005), pp. 156-159.

was an essential tool, or even the emblem, for craftsmen and technicians who were involved in all kind of architectural works. Symbolically, this ‘standard ruler’ in its ‘votive’ form, this precious collection of tables, ensures the control of time and space. Essential to Maat, the balance of which it is one of the guarantors, the cubit is preciously and perhaps secretly kept within the temple.[35]

These cubit rods are ritual and factitious objects, above all symbolic and not intended for a technical or a practical use. As a matter of fact, they often incorporate mistakes,[36] and the graduations

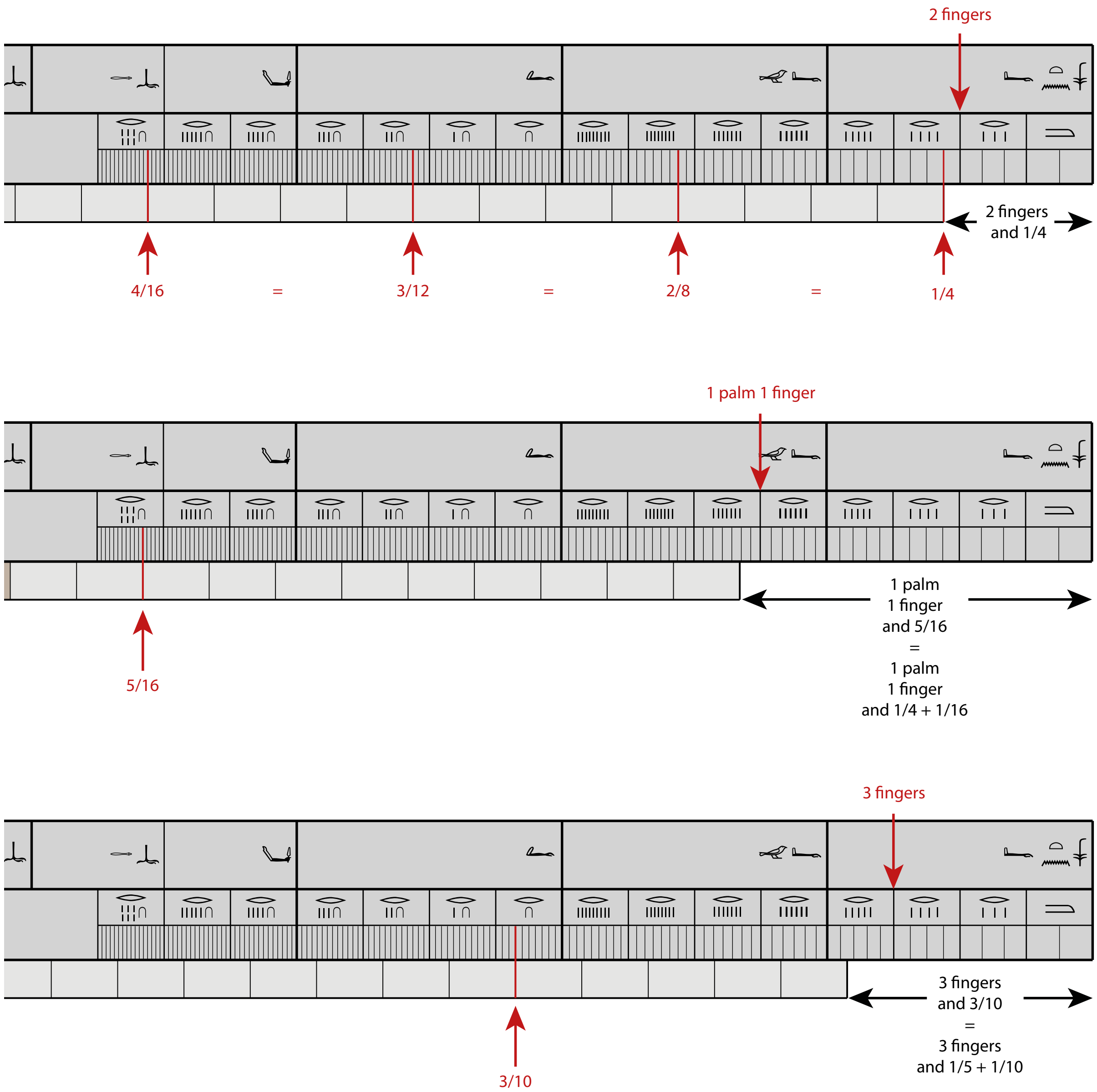


Fig. 4. The measuring method using a cubit rod and rule together suggested by the authors.

35. Zivie (1979), p. 343.
36. Zivie (1979), pp. 335-336; Lacau and Chevrier (1956), pp. 245-246, 248.

are sometimes clumsily drawn.[37] There can be no doubt that there was one, or even several standard rods, which were closely guarded and better manufactured to the expected accuracy, reference objects that inspired the replicas under discussion in this paper. This does not affect the analysis and the interpretation of the inscriptions whose meaning was not related to the quality of the reproduction.

The use of the cubit rod as a measuring ruler

The arrangements of the graduated parts show great consistency from one cubit to another. These cubit rods allow easy measurement of lengths that are equal to a whole number of fingers, and the expression of these in the required units of palms, small or great spans, sacred cubits, and so on. It is more complicated, at first sight, to see how they could have been used to take measurements involving subdivisions of a finger such as those listed on the face C.

Our modern numerical system is established on a base 10 just like in Ancient Egypt. This allows us to write decimal numbers which are in fact fractions of whole numbers over powers of ten. That is the reason why our rulers are graduated in decimeters, centimeters and millimeters; each part being equal to the tenth of the previous one.

The Egyptian numerical system was fundamentally different in its treatment of numbers less than one, as it used unit fractions to decompose single units into equal parts. A measurement less than one finger was then expressed as 1/2, 1/3, 1/4, 1/5, ... down to $1/16^{th}$ of a finger, which means in fact that the finger was divided into 2, 3, 4, 5, ... or 16 equal parts.[38] As it was materially impossible to graduate all these measurements in one single section, the Egyptians wrote the different subdivisions on subsequent divisions, one after the other in decreasing order.

Some scientists suppose that these marks and their associated fractions are only intended to reflect the Egyptian numerical system, without constituting any practical application.[39]

Such a point of view is surprising when one sees the contextual importance of the recorded data on these objects. It is very clear that the fractional subdivisions are an integral part of the graduated ruler and its measuring system. We will show that there is a clever practical measurement method that may explain the ordered fragmentation of digits, almost down to millimeter lengths.

It is unlikely that the system of subdivisions utilized would have required the user to move the ruler to take measurements in two stages (in fingers, and then in fractions of a finger). Such a clumsy process would contradict the demonstrated precision of the subdivisions. In fact, everything seems to indicate that the subdivisions are there to respond to various specific cases when the object to be measured did not coincide with a whole number of fingers.

If this cubit rod is used in conjunction with another, or with a simpler ruler subdivided only into whole fingers, the related graduations reveal a noteworthy property. The user first has to position the cubit rod alongside the object to be measured, then hold one side of the ruler against the rest of the cubit. The whole digit lines on this same edge then act as cursors that align against the cubit, either at an existing graduation, or between two graduations (fig. 4). In this last case the periodic offset of the 'cursor' from one finger to another on the ruler means that it eventually reaches a location where it coincides exactly with one of the fine cubit's subdivisions. A reading has to be taken at this coincidence and added to the number of whole digits measured alongside the object.

---

37. Lepsius (1865), p. 18 ; Sarton (1936), p. 401; Zivie (1972), p. 185, fig. 2. Some of them even comprise an incorrect number of graduations (Saint John (2000), pp. 14-15).

38. Michel (2014), p. 74.

39. Sarton (1936), pp. 401-402; Michel (2014), pp. 120-121.

Practical experimentation shows that this technique is undoubtedly effective, and this can explain the presence and arrangement of the subdivisions. According to our reconstruction, accurate measurement would have certainly required the use of the additional element that we suppose to be a ruler or a second cubit rod, but we can also imagine that a stem or a simple annotated papyrus could serve equally as well, with the benefit that they could be made and marked out by the scribes or artisans using the cubit rod which was available to them. Several similar and plausible scenarios can be envisaged.

As the subdivisions are only spread over 15 fingers, accurate measurement can be applied using this full method only to the lengths less than 10 fingers. Beyond this value all the subdivisions are no longer in a position available to read.

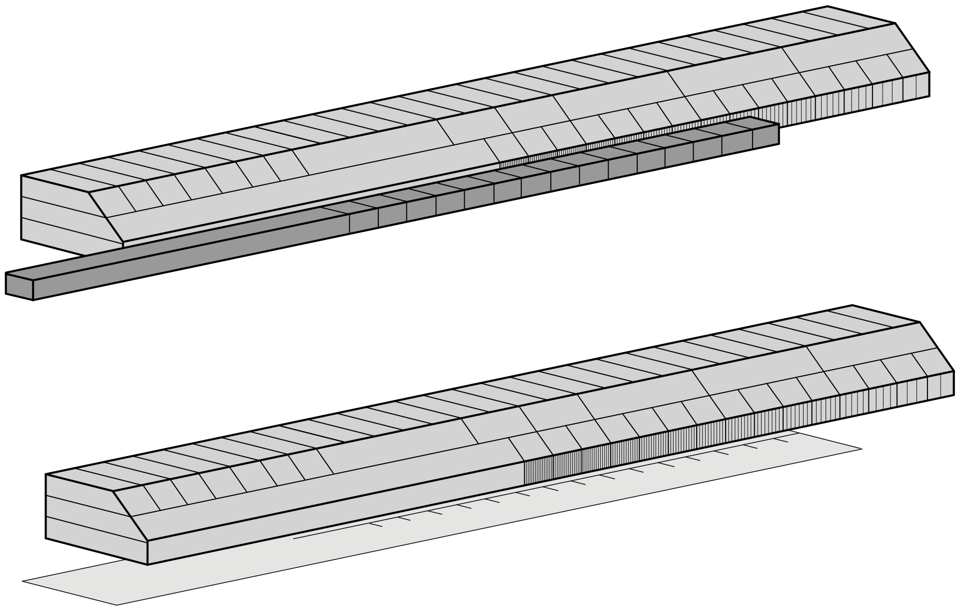


Fig. 5. Two possible methods for using fractions of a finger in the measurements.

This research has led to a plausible interpretation of an obscure part of the inscriptions reproduced on the ceremonial cubit rods. The arrangement of subdivisions makes a coherent set for measuring objects, following a technique that would have been easily available to Ancient Egyptians. It is highly doubtful that the graduations set out in order and engraved with a great accuracy on these cubits were conceived in that way without any practical purpose.

The explanation presented in the second part of this article demonstrates that the graduated ruler of such cubit rods was fully operational on the condition that it was used in conjunction with another metrical element (a cubit rod, marked papyrus, or marked reed stem). The measuring method we suggest would have been dedicated to small subjects requiring precision,[40] prefiguring in a rather primitive, but nevertheless rather clever form, the Vernier caliper that was invented during the 17th century A.D.

40. 1/16th of a finger is equal to 1.2 mm. Known mathematical texts do not detail any calculation involving such precise values (Michel (2014)). There is however one document in the archives of Abusir that reveals the measurement of an object with dimensions of fractions of a finger: pBM EA 10735 sheet 17 (Posener-Kriéger and Cenival (1968), pls. 23-24; Posener-Kriéger (1976), pp. 143-144, fig. 7). We would like to thank Luca Miatello for having brought it to our attention.

Bibliography

Arnold, D. (1991), *Building in Egypt. Pharaonic Stone Masonry*, New-York/Oxford.

Borchardt, L. (1920), *Die Geschichte der Zeitmessung und der Uhren*, Berlin/Leipzig.

Boylan, P. (1922), *Thoth, The Hermes of Egypt*, Oxford.

Carlotti, J.-Fr. (1995), 'Quelques réflexions sur les unités de mesure utilisées en architecture pharaonique', *Les Cahiers de Karnak* 10, pp. 127-140.

Chassinat, É. (1930), *Le temple d'Edfou* V, Cairo.

Chassinat, É. (1931), *Le temple d'Edfou* VI, Cairo.

Chassinat, É. (1932), *Le temple d'Edfou* VII, Cairo.

Clagett, M. (1995), *Ancient Egyptian Science. A Source Book*, vol. 2, *Calendars, Clocks, and Astronomy*, Philadelphia.

Clagett, M. (1999), *Ancient Egyptian Science. A Source Book*, vol. 3, *Ancient Egyptian Mathematics*, Philadelphia.

Gabra, S. (1969), 'Coudée votive de Touna el Gebel Hermopolis Ouest. La Khemenow pa Meket des Egyptiens', *MDAIK* 24, pp. 129-135.

Graefe, E. (1973), 'Einige Bermerkungen zur Angabe der *sṯꜣt*-Grösse auf der Weissen Kapelle Sesostris I', *JEA* 59, p. 72-76.

Hart, G. (2005), *The Routledge Dictionnary of Egyptian Gods and Goddesses*, London/New-York: Routledge.

Lacau, P. and Chevrier, H. (1956), *Une chapelle de Sésostris Ier à Karnak*, IFAO, Cairo.

Lepsius, K. R. (1865), *Die Alt-Aegyptische Elle und Ihre Eintheilung*, Berlin.

Lightbody, D. I. (2008), *Egyptian Tomb Architecture. The archaeological facts of pharaonic circular symbolism*, *Bar International Series* 1852, Oxford.

Michel, M. (2014), *Les mathématiques de l'Égypte ancienne : numération, métrologie, arithmétique, géométrie et autres problèmes*, Bruxelles: Safran.

Petrie, W. M. F. (1926), *Ancient Weights and Measures*, BSAE 39, London.

Posener-Kriéger, P. and Cenival, J.-L. (1968), *Hieratic Papyri in the British Museum. Fifth Series. The Abu Sir Papyri*, London.

Posener-Kriéger, P. (1976), *Les archives du temple funéraire de Néferirkarê Kakaï*, *BdE* 65, Cairo.

Saint John, M. (2000), *Three Cubits Compared*, London.

Sarton, G. (1936), 'On a Curious Subdivision of the Egyptian Cubit', *Isis* 25-2, pp. 399-402.

Schlott, A. (1969), *Die Ausmasse Ägyptens nach Altägyptischen Texten*, Tübingen.

Schlott-Schwab, A. (1972), 'Altägyptische Texte über Ausmaße Ägyptens', *MDAIK* 28, pp. 109-113, taf. XXIII-XXVIII.

Schlott-Schwab, A. (1981), *Die Ausmasse Ägyptens nach Altägyptischen Texten*, Wiesbaden.

Scott, N. E. (1942), 'Egyptian Cubit Rods', *The Metropolitan Museum of Arts Bulletin* 1- 1, pp. 70-75.

Zivie, A.-P. (1972), 'Un fragment inédit de coudée votive', *BIFAO* 71, pp. 181-188.

Zivie, A.-P. (1977a), 'L'ibis, Thot et la coudée', *BSFE* 79, pp. 22-41.

Zivie, A.-P. (1977b), 'Un fragment de coudée de la XIXe dynastie', *RdE* 29, pp. 215-223.

Zivie, A.-P. (1979),'Nouveaux aperçus sur les "coudées votives". L'apport original de deux fragments provenant de Basse Égypte', in J. Vercoutter (dir.), *Hommages à la mémoire de Serge Sauneron*, I, *BdE* 81/1, IFAO, Le Caire, pp. 319-343, pl. 49-50.

Zivie, A.-P. (1990), *Découvertes à Saqqarah : le vizir oublié*, Paris: du Seuil.

von Bomhard, A.-S. (1999), *Le calendrier égyptien. Une œuvre d'éternité*, London: Periplus Publishing.

Varieties and sources of sandstone used in Ancient Egyptian temples

J. A. Harrell[1]

From Early Dynastic times onward, limestone was the construction material of choice for Ancient Egyptian temples, pyramids, and mastabas wherever limestone bedrock occurred, that is, along the Mediterranean coast, in the northern parts of the Western and Eastern Deserts, and in the Nile Valley between Cairo and Esna (fig. 1). Sandstone bedrock is present in the Nile Valley from Esna south into Sudan as well as in the adjacent deserts, and within this region it was the only building stone employed.[2] Sandstone was also imported into the Nile Valley's limestone region as far north as el-'Sheikh Ibada and nearby el-'Amarna, where it was used for New Kingdom temples. There are sandstone temples further north in the Bahariya and Faiyum depressions, but these were built with local materials. The first large-scale use of sandstone occurred near Edfu in Upper Egypt, where it was employed for interior pavement and wall veneer in an Early Dynastic tomb at Hierakonpolis[3] and also for a small 3rd Dynasty pyramid at Naga el-Goneima.[4] Apart from this latter structure, the earliest use of sandstone in monumental architecture was for Middle Kingdom temples in the Abydos-Thebes region with the outstanding example the 11th Dynasty mortuary temple of Mentuhotep II (Nebhepetre) at Deir el-Bahri. From the beginning of the New Kingdom onward, with the exceptions of some portions of Karnak temple and especially Hatshepsut's mortuary temple at Deir el-Bahri, which are of limestone, Theban temples were built either largely or entirely of sandstone, and this was also true for most of the temples in the southern portion of the limestone region. When limestone and sandstone are both present in a temple, they are usually employed for different architectural applications with the sandstone particularly favored for segmented columns and architraves. Uniquely, however, in the Seti I temple at Abydos, limestone and sandstone are used side-by-side for wall reliefs with scenes beginning on one rock type and then continuing across the other.

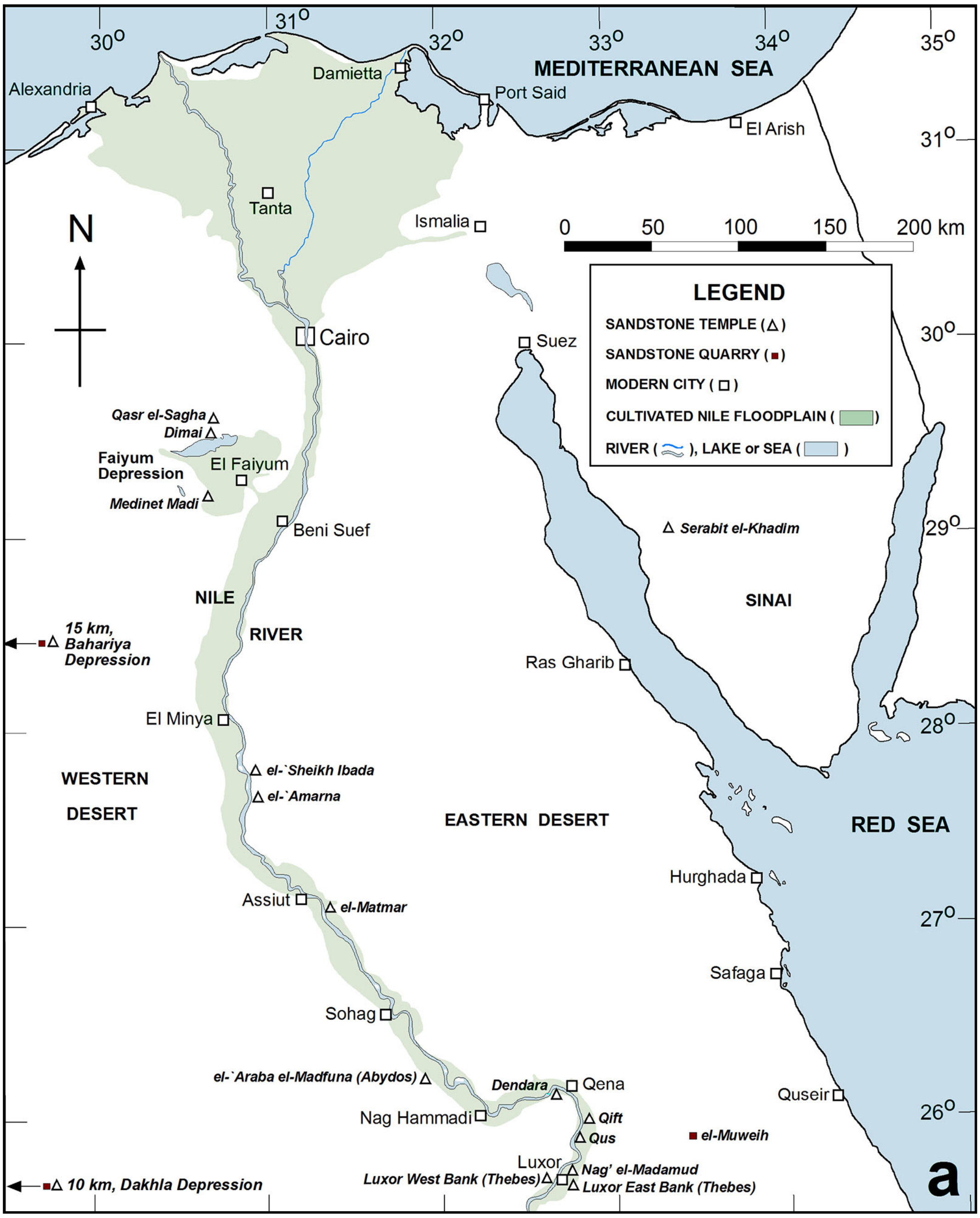
Appendix 1 lists the temples (and other monuments) containing significant amounts of sandstone and figure 1 shows their locations. There are undoubtedly temples missing from this list that are either destroyed, still undiscovered, or known but with unrecognized sandstone elements. The southernmost temple built by Egyptians, also of sandstone, is at Jebel Barkal near the west end of the Nile River's fourth cataract in Sudan.

1 Professor Emeritus of Geology, Department of Environmental Sciences, The University of Toledo, 2801 West Bancroft St., Toledo, Ohio 43606-3390, USA (e-mail: james.harrell@utoledo.edu, phone: 419-530-2193, fax: 419-530-4421).

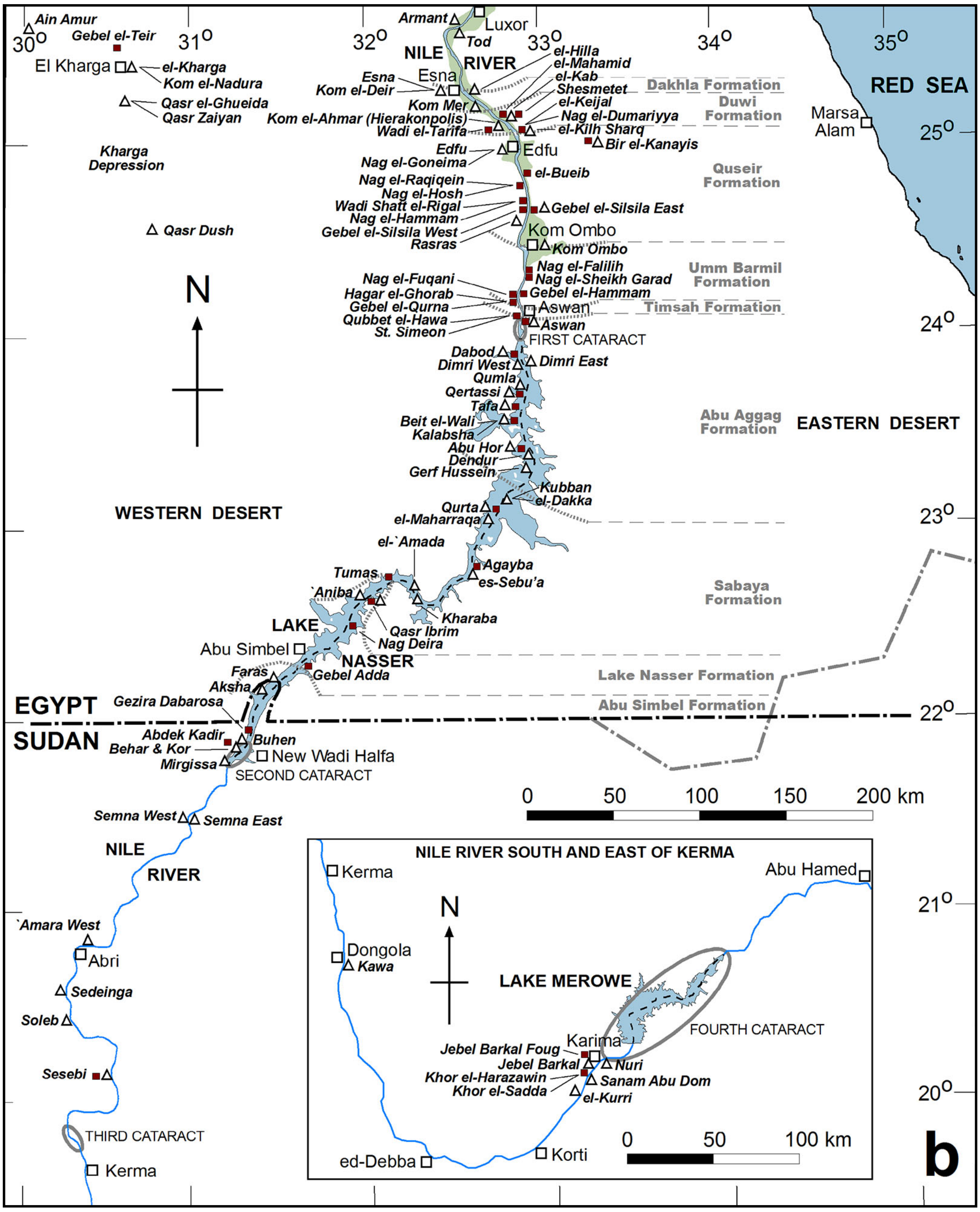
2 Harrell (2012a).

3 Quibell and Green (1902), pp. 3-7, 14, 51.

4 Marouard and Papazian (2012).


30°
31°
32°
33°
34°
35°
MEDITERRANEAN SEA
Alexandria
Damietta
Port Said
El Arish
31°
Tanta
Ismalia
0 50 100 150 200 km
N
LEGEND
SANDSTONE TEMPLE (△)
SANDSTONE QUARRY (■)
MODERN CITY (□)
CULTIVATED NILE FLOODPLAIN ( )
RIVER ( ), LAKE or SEA ( )
Cairo
Suez
30°
Qasr el-Sagha
Dimai
Faiyum Depression
El Faiyum
Medinet Madi
Beni Suef
Serabit el-Khadim
29°
NILE
RIVER
SINAI
15 km, Bahariya Depression
Ras Gharib
El Minya
28°
el-`Sheikh Ibada
el-`Amarna
WESTERN
DESERT
EASTERN DESERT
RED SEA
Hurghada
Assiut
el-Matmar
27°
Safaga
Sohag
el-`Araba el-Madfuna (Abydos)
Dendara
Qena
Quseir
Nag Hammadi
Qift
Qus
el-Muweih
26°
Luxor
Nag' el-Madamud
Luxor West Bank (Thebes)
Luxor East Bank (Thebes)
10 km, Dakhla Depression
a

1a.



1b.

Fig. 1a-b. Maps of Egypt and northern Sudan showing the locations of ancient sandstone temples and quarries.

The choice of sandstone

The preference for sandstone over limestone as a building material coincided with the transfer of religious and political authority from Memphis near Cairo to Thebes (Luxor) at the beginning of the 18th Dynasty. Thebes was closer to the sandstone sources and this probably was a factor, but more importantly the Egyptians at this time also recognized that sandstone was superior to limestone in terms of the strength and size of blocks obtainable, and this permitted the construction of larger temples with longer architraves and roofing slabs.[5] The hardness and strength of sandstone depends on the amount and type of cementing agent holding the sand grains together. The most common cements in Egyptian sandstones are quartz, iron oxides (limonite and hematite), calcite, and clay minerals. When these cements are sparse, the rock is friable and so easily disaggregated, and when abundant and filling all the intergranular pore spaces, the rock is well-indurated and durable. Sandstone with abundant quartz cement is the hardest of all and is referred to as 'silicified sandstone,' one of ancient Egypt's most important ornamental and utilitarian stones. Silicified sandstone was not used as a building material for temples and so will not be further considered here.[6] It should be noted, however, that on at least one occasion this rock was employed for a small shrine, the so-called 'red chapel' of Hatshepsut in Karnak's Open-Air Museum.

Megascopic properties

Sandstone in temples can usually only be examined megascopically (i.e., with at most a magnifying lens) with the observable properties limited to grain size, bedding, and color. Additional information on texture and especially mineralogy is provided by microscopic (i.e., petrographic or thin section) analysis, and geochemistry can identify amounts of trace elements. Such analyses, however, are destructive and require samples that are not normally available to those studying sandstone monuments.

Throughout most of the world, grain size in sandstone and other clastic sedimentary rocks is specified according to the Udden-Wentworth grain size scale (table 1). In studies of Egyptian rocks by German geologists, however, the grain size terminology usually follows the DIN (Deutschen Instituts für Normung) 4022 scale.[7] This scale recognizes only three grain size divisions for sand: coarse (2.000-0.630 mm), medium (0.630-0.200 mm) and fine (0.200-0.063 mm). In the present paper, it is the Udden-Wentworth scale's five-fold division for sand that is employed throughout. The modal or average grain size of temple sandstones is easily determined through the use of a visual comparator. There are many such aids commercially available, but the author prefers the one shown in figure 2. This is placed against a sandstone surface and viewed along the right edge with a magnifying lens (5-10X) to match the sand grains in the rock with a size-calibrated image on the comparator.

5 Clarke and Engelbach (1930), pp. 12-13; Arnold (1991), pp. 183-184.

6 For more information on the varieties and sources of silicified sandstone see Klemm *et al.* (1984); Klemm and Klemm (1993), pp. 283-303; (2008), pp. 215-231; Heldal *et al.* (2005); Harrell and Madbouly (2006); Knox *et al.* (2009); and Harrell (2012b; 2012c).

7 For example, Klitzsch *et al.* (1987); Hermina *et al.* (1989); Klemm and Klemm (1993; 2008).

<table>
<tr><th colspan="2">SEDIMENT NAME</th><th>GRAIN SIZE RANGE</th><th colspan="2">ROCK NAME[8]</th></tr>
<tr><td rowspan="4">GRAVEL</td><td>boulder</td><td>over 256 mm</td><td colspan="2" rowspan="4">conglomerate
(if rounded clasts)
or
breccia
(if angular clasts)</td></tr>
<tr><td>cobble</td><td>64 to 256 mm</td></tr>
<tr><td>pebble</td><td>4 to 64 mm</td></tr>
<tr><td>granule</td><td>2.00 to 4.00 mm</td></tr>
<tr><td rowspan="5">SAND</td><td>very coarse grained</td><td>2.00 to 1.00 mm</td><td colspan="2" rowspan="5">sandstone</td></tr>
<tr><td>coarse grained</td><td>1.00 to 0.50 mm</td></tr>
<tr><td>medium grained</td><td>0.50 to 0.25 mm</td></tr>
<tr><td>fine grained</td><td>0.25 to 0.125 mm</td></tr>
<tr><td>very fine grained</td><td>0.125 to 0.062 mm</td></tr>
<tr><td rowspan="2">MUD</td><td>silt</td><td>0.004 to 0.062 mm</td><td>silty shale if fissile[9], otherwise siltstone</td><td rowspan="2">mudstone</td></tr>
<tr><td>clay</td><td>less than 0.004 mm</td><td>clayey shale if fissile[9], otherwise claystone</td></tr>
</table>

Table 1. The Udden-Wentworth grain size scale for clastic sedimentary rocks.

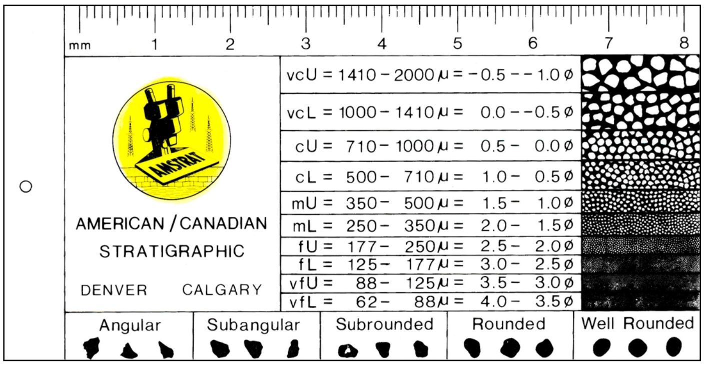


Fig. 2. Grain-size comparator of the American-Canadian Stratigraphic Company (Denver, Colorado, USA). The upper (U) and lower (L) halves of the five Udden-Wentworth sand-size classes (vf, f, m, c and vc) are shown with a grain-roundness comparator along the bottom edge. Grain sizes are given in μm and also in phi (Φ) notation, where [phi size] = $-\log_2$ [mm size]).

8 Rock names reflect the predominant grain size. Some coarser or finer grains can also be present in a given rock type.
9 Fissility is the property of a mudstone that causes it to break into thin, platy fragments up to a few millimeters thick.

When sandy sediment is deposited it can exhibit a number of bedding types depending on the environmental conditions. The principal ones and the easiest to recognize in temple sandstones are planar bedding, and tabular and trough cross-bedding. These structures are defined by the attitude of laminations between the major bedding planes (fig. 3). The laminations can be difficult to see, however, on dirty or weathered rock surfaces. When no laminations are present, the rock is said to exhibit massive bedding. Sometimes the laminations are merely indistinct and thus give the false impression of massive bedding. All bedding types are encountered in Egyptian sandstones, but by far the most common is tabular cross-bedding (fig. 4).

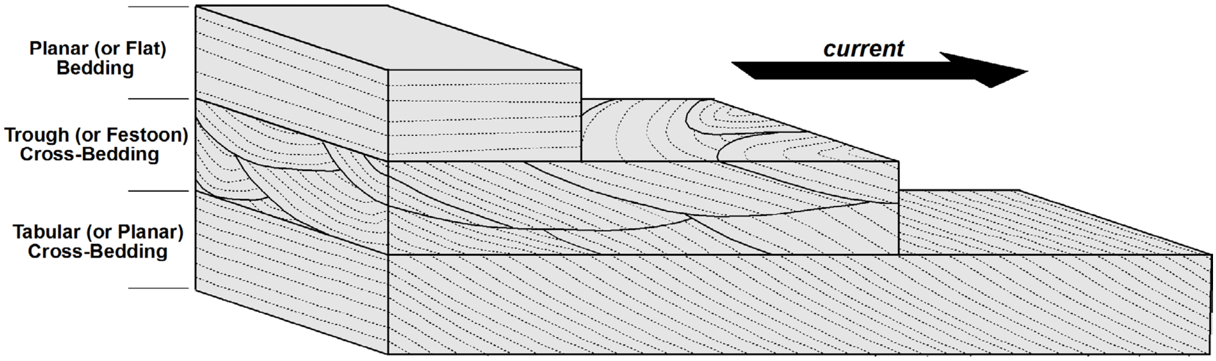


Fig. 3. Diagram illustrating planar bedding, and trough and tabular cross-bedding. The heavier lines represent major bedding planes and the lighter ones are the internal laminations.

Fig. 4. Tabular cross-bedding in sandstone at the Nag el-Hammam quarry. Smallest scale division is 1 cm. The scale rests on a major bedding plane separating two cross-bed sets.

Fig. 5. Typical drab-colored sandstone (very fine-grained) from the el-Mahamid quarry.

Fig. 6. Typical drab-colored sandstone (fine-grained) from the Gebel el-Silsila quarry.

With few exceptions, the sandstone quarried in Ancient Egypt has an internal coloration that varies from light shades of gray, yellow, orange, brown or pink, or mixtures thereof (figs. 5-6). Yellowish-brown is the most common hue. Such normally colored sandstones, which vary from very fine- to coarse-grained, can be collectively referred to as drab-colored. Nearly white sandstones are occasionally encountered and these constitute another distinct color variety.

A very different-looking sandstone was employed only during the 12th and especially the 11th Dynasties and this is medium-grained with a uniform, moderately dark reddish- to mainly purplish-brown color (fig. 7). It was used for several temples in the Abydos-Thebes region, including the Osiris-Khentyimentyu temple at Kom el-Sultan in Abydos,[10] the north temple of Min and Isis in Qift,[11] the Senwosret I temple within the Amun temple complex at Karnak in Luxor,[12] and on the Luxor West Bank in the Amun temple at Medinet Habu,[13] and the Mentuhotep II mortuary temple at Deir el-Bahri.[14] It is probably not a coincidence that the 11th Dynasty saw both the first use of purplish sandstone in Egypt and also the opening of the first mine for amethyst, a purplish gemstone, near Wadi el-Hudi, 25 km southeast of Aswan.[15] Also in the Middle Kingdom, there was a surge in the popularity of purplish-red garnet for jewelry. It is thus apparent that the color purple was especially favored during this period but the reason for this is unknown.

Fig. 7. Purplish sandstone column fragment in the Mentuhotep II temple at Deir el-Bahri. Smallest scale division is 10 cm.

10 Petrie (1903, vol. 2), pp. 14-16, 33; Petrie (1938), pp. 24-25.
11 Petrie (1938), pp. 24-25.
12 François Larché, pers. comm. (2015).
13 Hölscher (1939), pp. 4-5.
14 Clarke (1910), pp. 13-14; Arnold (1979), p. 31.
15 Shaw and Jameson (1993).

A final color variety is the light green sandstone employed in Karnak temple's 5th pylon (fig. 8), which dates to the reign of Thutmose I.[16] This rock, which is fine-grained with tabular cross-bedding, is only known from this example. It may have been chosen for the symbology represented by its color, with green signifying rebirth in the afterlife (as represented by Osiris, whose figure is typically depicted in green) as well as fertility and joy. Challenging this suggestion, however, is the fact that the 5th pylon was originally covered by a limestone casing with the green sandstone hidden from view.

Fig. 8. Greenish sandstone block in the 5th pylon at Karnak temple. Note the chisel marks.

Determining sandstone's color can be problematical because its appearance on dirty, weathered exterior surfaces can be very different from what is seen internally on fresh breaks. On quarry and temples walls and especially on natural outcrops, the sandstone usually has a fairly uniform light brown color. Where long exposed to the elements, the rock will develop a patina known as 'desert varnish'. This has a variable composition but normally consists of iron and manganese oxides plus clay minerals.[17] It thickens and darkens with age, eventually becoming nearly black and completely obscuring a rock's internal color. Color determination is further complicated when working with archaeological objects because, of course, these cannot be broken to reveal their true (internal) color. The best one can do is look for relatively fresh breaks in the external surfaces that occurred during excavation or subsequent handling. These are not always present or recognizable, however. And finally, color perception varies from person to person and under different lighting conditions, and so it is often helpful to use a standard color guide, such as the Geological Society of America's 'Rock-Color Chart' (Boulder, Colorado, USA).

16 Larché (2009), p. 151.
17 Lucas (1905); Potter and Rossman (1977; 1979).

Internal sandstone colors in shades of yellow and brown are caused by the presence of hydrated iron oxides (i.e., iron hydrates). These are collectively referred to as 'limonite' and represent a number of poorly crystallized phases with the generalized formula of $FeO \bullet OH \bullet nH_2O$ or $Fe_2O_3 \bullet nH_2O$. Goethite ($FeO[OH]$ or $HFeO_2$) is a common, well-crystallized phase within the iron hydrate group. Shades of pink, red and purple are the result of anhydrous iron oxide (i.e., hematite; Fe_2O_3). Some Egyptian sandstones have an orangey coloration. Orange is a blend of red and yellow and so in rocks this probably represents a mixture of hematite and limonite. When iron oxides are absent, the rock has a light grayish to nearly white color which is the natural hue of the quartz sand grains. The green sandstone in Karnak's 5th pylon gets its color from the presence of sand-size grains of dark green glauconite, a type of clay mineral.

A final megascopic attribute of temple sandstones is the tool marks commonly left on their surfaces when blocks were dressed to adjust their size and shape (e.g., fig. 8). Indications of when the dressing was done can be gleaned from the different forms taken by the marks and the metal residues of the tools that made them.[18]

Formations

The various sandstones used in Egyptian temples were collectively referred to in the past as the Nubian Sandstone. Stratigraphical difficulties with this designation caused geologists to later redefine the sandstones into numerous, and at times conflicting, formations. A sedimentary formation is a sequence of strata distinct from the rock layers both above and below by virtue of its lithology or paleontology, and thus is a mappable stratigraphic unit. The formations described in table 2 for Egypt are the most widely accepted ones,[19] and these are defined primarily by their fossil content. Despite the new terminology, these rocks are still informally referred to as the Nubian Sandstone or Nubian Group. More formally in Sudan, the correlative stratigraphic units are usually identified simply as the Nubian Sandstone Formation. From the table it can be seen that the petrology of a sandstone will vary somewhat according to the formation supplying it. The geologic ages of sedimentary strata (and consequently also formations) decrease from south to north in the Nile Valley due to their slight (approximately 2 degree) northerly inclination, and this means that the sandstone properties also change in a downriver direction. The boundaries between the formations in the Nile Valley are shown in figure 1.

Quarries and provenance determinations

Appendix 2 lists the 44 known ancient sandstone quarries in Egypt and northern Sudan, and figure 1 shows their locations. A locality name and coordinates are provided for each quarry along with its period of activity, size, current status, and, in some cases, a general petrological description. Although the list is long, it is far from complete. There are undoubtedly more quarries awaiting discovery, as well as others that are forever lost because they have been destroyed through urban growth or especially as a result of modern quarrying for rough construction stone. Although not destroyed, numerous sandstone quarries are no longer accessible because they are now under Lake Nasser.

18 Arnold (1991), pp. 41-47, 257-259; Harrell and Storemyr (2013), pp. 21-28.
19 These are the formations introduced by Klitzsch *et al.* (1987) and Hermina *et al.* (1989).

Dakhla Formation (Upper Cretaceous – Late Campanian and Maastrichtian stages to Paleocene; ~74-60 mya): interbedded sandstone, silty and clayey mudstones, and limestone.
Duwi Formation (Upper Cretaceous – Middle Campanian to Early Maastrichtian stages; ~78-70 mya): very fine- to medium-grained sandstone with mainly massive to planar bedding and occasional tabular cross-bedding plus interbedded silty and clayey mudstones, limestone, and phosphorite.
Quseir Formation (Upper Cretaceous – Early to Late Campanian stage; ~82-74 mya): very fine- to mainly fine- to medium-grained sandstone with planar bedding to mainly tabular cross-bedding plus interbedded silty and clayey mudstones, and phosphorite.
Umm Barmil Formation (Upper Cretaceous – Santonian to Early Campanian stages; ~85-82 mya): in the upper part, mainly fine- to medium-grained sandstone with tabular cross-bedding and interbedded silty and clayey mudstones and oolitic iron ore; and in the lower part, medium- to coarse-grained sandstone with tabular cross-bedding.
Timsah Formation (Upper Cretacous – Coniacian to Santonian stages; ~90-85 mya): medium- and coarse-grained to mainly fine-grained sandstone with planar-bedding to mainly tabular and trough cross-bedding plus interbedded silty and clayey mudstones, and oolitic iron ore.
Abu Aggag Formation (Upper Cretaceous – Turonian stage; ~94-90 mya): medium- to coarse-grained sandstone, occasionally pebbly, kaolinitic and often ferruginous, with mainly trough cross-bedding plus interbedded pebble-cobble conglomerate
Taref Formation (Upper Cretaceous – Turonian stage; ~94-90 mya): mainly fine- to coarse-grained sandstone with tabular cross-bedding and, near the base, interbedded conglomerate.
Bahariya Formation (Upper Cretaceous – Cenomanian stage; ~100-94 mya): interbedded sandstone and silty and clayey mudstone.
Sabaya Formation (Lower to Upper Cretaceous – Albian to Early Cenomanian stages; ~113-98 mya): fine-grained (upper part) and medium- to coarse-grained (lower part) sandstone with abundant trough to mainly tabular cross-bedding plus interbedded conglomerate and silty mudstone.
Lake Nasser Formation (Lower Cretaceous – Aptian stage; ~125-113 mya): interbedded fine- to coarse-grained sandstone with tabular to trough cross-bedding and planar bedding, and silty and clayey mudstones.
Abu Simbel Formation (Upper Jurassic to Lower Cretaceous – Oxfordian to Barremian stages; ~163-125 mya): interbedded tabular to trough cross-bedded sandstone and mudstone.

Table 2. Egyptian Sandstone Formations.[20]

As a practical matter, the building stones used at ancient construction sites usually came from a quarry in the immediate neighborhood. This quarry was probably on the upriver side of a site because it was easier to float a heavily loaded boat down the Nile than to sail it upriver against the current, even with the prevailing northerly wind. A notable exception to the local derivation of building stones is the high-quality sandstone from Gebel el-Silsila. This quarry, the most extensive in Egypt for sandstone, provided large, fracture-free blocks of uniform color and texture. It was

20 Formation names and chronologies are those of Hermina *et al.* (1989) as used on the geologic maps of Klitzsch *et al.* (1987). The years before present (mya – millions of years ago) for the stratigraphic stages are taken from the International Chronostratigraphic Chart, version 2016/04 (International Commission on Stratigraphy). Petrological descriptions are a synthesis of multiple sources, including Attia (1955), Van Houten and Bhattacharyya (1979), Ward and McDonald (1979), Hermina *et al.* (1989), Ahmed *et al.* (1993), Klemm and Klemm (1993, 2008), Issawi *et al.* (1999), and fieldwork by the present author. The information is incomplete for some formations.

the principal building material for temples in the Theban region, over 100 km to the north, as documented by ancient inscriptions.[21] It was no doubt used for many other distant structures, especially those in a downriver direction. The second largest sandstone quarry is at the now drowned site of Qertassi and although it apparently did not supply rock of as high a quality as that coming from Gebel el-Silsila, it was mainly used outside its immediate area. Inscriptions tell us, for example, that it was employed for the Philae temple complex 35 km to the north,[22] and it was probably also used for other structures in the Aswan area. For most temples, however, the quarry supplying the stone will be found close at hand. It is expected, therefore, that more quarries remain to be discovered, especially near the Nubian temples along the Nile in southern Egypt and northern Sudan.

It is not yet possible to identify by analytical means the specific quarry supplying a particular sandstone, but the formation, and hence the general location in the Nile Valley, can sometimes be established. For example, very fine-grained sandstone with planar bedding almost certainly comes from the Duwi or Quseir Formation whereas coarse-grained sandstone with trough cross-bedding probably comes from one of the formations near Aswan or to the south of it. Fine- to medium-grained, tabular cross-bedded sandstones – the predominant lithology – can come from any formation. Further distinctions require petrographic microscopy. There are just a few published sources of petrographic information on Egyptian sandstones in the Nile Valley: two for natural outcrops in the Aswan[23] and el-Mahamid[24] areas, another for ancient quarries throughout Egypt but only providing incomplete qualitative data,[25] and the last for the ancient Gebel el-Silsila quarry.[26] The present author has also done petrographic analyses of samples from several quarries between Esna and Aswan as well as from two sandstone temples closely associated with quarries south of Aswan. With one exception, all the aforementioned data combined still represent too few samples to say anything definitive about the mineralogical differences among quarries or formations. The exception is total feldspar content (i.e., orthoclase + microcline + plagioclase). This ranges between 5 and 15% for the el-Mahamid, el-Keijal, el-Bueib and Nag el-Raqiqein quarries – all within 20 km of Edfu – with the first two in the Duwi Formation and the last two in the upper part of the underlying Quseir Formation. All other tested quarries south of Nag el-Raqiqein have a total feldspar content of less than 5%. These percentages, all from the author's petrographic analyses, are provided in appendix 2. The feldspar-rich sandstones are what petrologists call 'arkose', 'subarkose' or 'arkosic arenite', depending on the classification scheme followed, with all the other sandstones, except the glauconite-rich ones, termed 'quartz arenite'. Other minerals in Egyptian sandstones show no consistent differences among quarries and formations, at least based on the currently available sample data.

The finding for feldspar content is supported by the trace element analyses of samples from four quarries: el-Mahamid, Nag el-Falilih, Nag el-Sheikh Garad and Gebel el-Silsila.[27] It was found that rubidium is significantly higher for el-Mahamid than for the other three quarries. Rubidium is a trace element associated with feldspar and so it is to be expected that it will be high in sandstones rich in this mineral. Because feldspar grains are more easily broken and abraded than quartz grains,

21 Breasted (1906, vol. 4), pp. 10-12; Weigall (1910), pp. 358-359; Kitchen (1991); Kramer (2009).

22 Weigall (1907), pp. 62-63; Clarke and Engelbach (1930), p. 15.

23 Shukri and Ayouti (1953).

24 Ahmed and Hussein (1983).

25 Klemm and Klemm (1993), pp. 225-281; (2008), pp. 167-213.

26 Fitzner *et al.* (2003).

27 Klemm and Klemm (1993), pp. 279-281, figs. 328-329; (2008), pp. 212-213, figs. 328-329. El-Mahamid is the Klemms' El Kab quarry, and Nag el-Falilih and Nag el-Sheikh Garad together are their El Gaaphra quarry.

which are the main constituent of sandstone, the amount of feldspar in sand tends to increase with decreasing grain size. It is this relationship that probably accounts for the differences in feldspar content among quarries, although it is also possible the feldspar content reflects different geologic sources for the sand.

The source of the Middle Kingdom's purplish sandstone is unknown. The quarries at Qubbet el-Hawa, Nag el-Hammam and Wadi Shatt el-Rigal are previously suggested possibilities,[28] but all can be excluded. None possesses beds of medium-grained sandstone of the requisite color that are at least 1 m thick, the minimum dimension required for the largest architectural elements and statues cut from the purplish sandstone. The most likely source at present appears to be the Gebel el-Silsila quarry but more fieldwork is needed to evaluate this possibility. This quarry is also the only known source of a white sandstone, which was used to a minor extent in the Karnak temple.

There is no known quarry that could have supplied the green glauconitic sandstone at Karnak. This rock is closely associated with phosphatic deposits (phosphorite) in the upper part of the Quseir Formation and also especially in the overlying Duwi Formation (table 2).[29] There are numerous, thick glauconitic sandstone beds in both formations, but only in the Western Desert's Bahariya, Dakhla and Kharga Depressions. Rare, thin-bedded occurrences of this rock have been reported from the Nile Valley, but with no specific localities identified.[30] If beds of glauconitic sandstone are to be found along the Nile, it is most likely to be near Edfu, where there are outcrops of phosphatic rocks in the Quseir and Duwi Formations. This is further indicated by a sample of glauconitic sandstone from Karnak's 5th pylon that was analyzed by the author and found to contain 6.3% total feldspar, which is consistent with a derivation from one of these formations. If an 18th Dynasty quarry for glauconitic sandstone once existed near Edfu, it may have been destroyed by the extensive phosphate mining that occurred in this region beginning in the early 1900's.

Although the megascopic properties of sandstone may not allow the identification of a specific formation or quarry, they are still useful for recognizing that multiple sources of building materials were used in different temples or in different construction phases of a single temple. What is needed, therefore, is a systematic study of sandstone used in Egyptian temples for purposes of both basic documentation and source characterization. More research is also needed on the sandstone quarries, including further megascopic and petrographic descriptions as well as an analysis of pottery to be better establish their ages.

Conclusions

Sandstone was the principal building stone used in Upper Egypt and Nubia from the Middle Kingdom onward. It came from forty-four known quarries (and others yet undiscovered) that were excavated in eleven geologic formations, all informally referred to as the Nubian Sandstone. This rock can be quite variable in its grain size, bedding type, color, and mineralogy. These properties can sometimes identify the formation – and, hence, the general geographic location of the source – for a sandstone used in a temple. For example, a quarry in the Duwi Formation or upper part of the Quseir Formation, and thus in the Edfu region, is indicated by either a greenish (glauconitic) sandstone, a sandstone of any color containing over 5% total feldspar, or a very fine-grained sandstone with planar bedding. It is not currently possible to recognize specific quarries for these or any other variety of sandstone used in temples, except where these associations are indicated in ancient inscriptions.

28 Arnold (1979), p. 31; Klemm and Klemm (1993), pp. 238-240; (2008), pp. 177-178.

29 Hermina *et al.* (1989), p. 126; Glenn (1990); Glenn and Arthur (1990); Baioumy (2007); Baioumy and Boulis (2012a; 2012b).

30 Ghanem *et al.* (1968), stratigraphic column; Baioumy (2007), fig. 2; Craig Glenn, pers. comm. (2016).

Appendix 1. Ancient Egyptian sandstone temples[31]

LOCATION[32]	MONUMENT and DATE[33]	OTHER MATERIALS and STATUS
Nile Valley		
el-Sheikh `Ibada [Gr. Antinoopolis]: on EB at 27° 48.455' N, 30° 52.373' E	temple of Ramesses II [NK19]	minor limestone; largely destroyed
el-`Amarna [Eg. Akhetaten]: on EB at 27° 38.720' N, 30° 53.760' E	small Aten temple of Akhenaten [NK18]	mostly limestone; largely destroyed
Matmar: on EB at 27° 6.388' N, 31° 19.832' E	combined Aten and Seth temples of Akhenaten and Ramesses II [NK18-19]	mostly limestone?; destroyed
el-`Araba el-Madfuna [Eg. Abedju; Gr. Abydos]: on WB at (1) 26° 11.516' N, 31° 54.671' E; (2) 26° 11.507' N, 31° 54.603' E; (3) 26° 11.188' N, 31° 54.982' E; (4) 26° 11.090' N, 31° 55.140' E	(1) Osiris temple [NK18 & LP30]	mostly limestone?; largely destroyed
	(2) Osiris-Khentyimentyu temple at Kom el-Sultan [OK-LP30]	mostly mud brick; largely destroyed
	(3) cenotaph temple of Ramesses II [NK19]	mostly limestone; largely destroyed
	(4) Osiris temple of Seti I [NK19]	mostly limestone; largely intact
Dendara [Eg. Iunet and Tantere; Gr. Tentyris]: on WB at 26° 8.520' N, 32° 40.210' E	Hathor temple [Pt-R; minor LP30]	intact
Qift [Eg. Gebtu; Gr. Coptos]: on EB at (1) 25° 59.804' N, 32° 48.973' E; (2) 25° 59.773' N, 32° 48.991' E; (3) 25° 59.741' N, 32° 48.996' E	(1) north temple of Min & Isis [Pt-R; minor MK12, NK18 & LP26]	largely destroyed
	(2) middle temple [Pt-R; minor MK12, 3IP22 & NK18]	largely destroyed
	(3) south temple of Geb [Pt; minor LP30]	largely destroyed
Qus [Eg. Gesa or Gesy; Gr. Apollinopolis Parva]: on EB at 25° 54.954' N, 32° 45.847' E	Haroeris and Heqet temple [Pt]	largely destroyed
Nag' el-Madamud [Eg. Madu]: on EB at 25° 44.051' N, 32° 42.606' E	Montu temple [Pt-R; minor MK12, NK18 & LP?]	minor limestone; largely destroyed
Luxor East Bank [Eg. Waset and Ipet-Resyt; Gr. Thebes and Diospolis Magna]: at (1) 25° 43.111' N, 32° 39.487' E; (2) 25° 42.005' N, 32° 38.367' E; (3) connecting (1) and (2)	(1) Karnak Amun temple complex [NK18-20; minor MK12, 3IP21-23, LP25-26, LP29-30, Ma, & Pt-R]	moderately intact
	(2) Luxor Amun temple [NK18-19; minor NK20, LP25, LP30, & Pt-R]	largely intact
	(3) Avenue of sphinxes [LP30]	moderately intact

31 Includes all free-standing temples and attached courts of rock-cut temples (and also pyramids and fortresses) that are either entirely or partly built with sandstone. The principal sources of information are: *Description de l'Égypte* (1809-29), Wilkinson (1847), Weigall (1907; 1910), Baedeker (1929), Survey of Egypt – 1:100,000 topographic maps (1920's and 1930's), Fakhry (1973-74), Seton-Williams and Stocks (1988), Murnane (1996), Gohary (1998), Baines and Malek (2000), and Wilkinson (2000) as well as field observations by the author and the 'Temple Explorer' website: http://temple.egyptien.egyptos.net/temples/temples.php. Ancient Egyptian (Eg.), Greco-Roman (Gr.) and Kushite (Ku) names are given where known.

32 Temples and other structures are listed from north to south.

33 Construction dates are given in brackets using the following abbreviations: ED = Early Dynastic, OK = Old Kingdom, MK = Middle Kingdom, NK = New Kingdom, LP = Late Period, Nap = Napatan period, Mer = Meroitic period, Ma = Macedonian period, Pt = Ptolemaic period, R = Roman period, and B = Byzantine period. Numbers after abbreviations are dynasties. Note that LP26-R in Egypt is contemporary with Nap-Mer in Sudan.

Luxor West Bank: at (1) 25º 44.287' N, 32º 36.415' E; (2) 25º 44.274' N, 32º 36.357' E; (3) 25º 44.241' N, 32º 36.370' E; (4) ~25º 43.98' N, 32º 37.01' E; (5) 25º 43.965' N, 32º 37.684' E; (6) 25º 43.815' N, 32º 36.782' E; (7) 25º 43.738' N, 32º 36.128' E; (8) 25º 43.728' N, 32º 36.685' E; (9) 25º 43.656' N, 32º 36.629' E; (10) 25º 43.621' N, 32º 36.513' E; (11) 25º 43.615' N, 32º 36.471' E; (12) 25º 43.501' N, 32º 36.386' E; (13) 25º 43.327' N, 32º 36.221' E; (14) 25º 43.309' N, 32º 36.066' E; (15) 25º 43.293' N, 32º 36.226' E; (16) 25º 43.261' N, 32º 36.580' E; (17) 25º 43.193' N, 32º 36.044' E; (18) 25º 43.139' N, 32º 36.121' E; (19) 25º 43.023' N, 32º 36.037' E; (20) 25º 41.716' N, 32º 34.706' E	(1) Hatshepsut mortuary temple at Deir el-Bahri [NK18]	mostly limestone; moderately intact
	(2) Tuthmose III mortuary temple at Deir el-Bahri [NK18]	minor limestone; largely destroyed
	(3) Mentuhotep II mortuary temple at Deir el-Bahri [MK11]	minor limestone; largely destroyed
	(4) Ramesses IV mortuary temple [NK20]	destroyed with building stone unknown but probably including sandstone
	(5) Seti I mortuary temple at Qurna [NK19]	largely intact
	(6) Tuthmose III valley temple at Qurna [NK18]	largely destroyed
	(7) Hathor temple at Deir el-Medina [Pt]	largely intact
	(8) Amenhotep II mortuary temple at Qurna [NK18]	largely destroyed
	(9) Ramesses II mortuary temple, the Ramesseum [NK19]	minor limestone; moderately intact
	(10) Tuthmose IV mortuary temple [NK18]	largely destroyed
	(11) Wezmose mortuary temple [NK 18]	destroyed with building stone unknown but probably including sandstone
	(12) Merenptah mortuary temple [NK19]	common limestone; largely destroyed
	(13) Amenophis, son of Hapu, mortuary temple [NK18]	mostly mud brick; largely destroyed
	(14) Ay and Horemheb mortuary temple [NK18]	mostly mud brick; largely destroyed
	(15) Thutmose II mortuary temple [NK18]	destroyed with building stone unknown but probably including sandstone
	(16) Amenhotep III mortuary temple at Kom el-Hetan [NK18]	minor limestone; largely destroyed
	(17) Ramesses III mortuary temple at Medinet Habu [NK20]	largely intact
	(18) Amun temple at Medinet Habu [NK18; minor MK11, NK20, LP25-26, LP29-30, Ma, Pt & R]	largely intact
	(19) Toth temple, the Qasr el-Aguz, at Medinet Habu [Pt]	largely intact
	(20) Isis temple, the Deir el-Shalwit [R]	intact
Armant [Eg. Iuny; Gr. Hermonthis]: on WB at 25º 37.328' N, 32º 32.664' E	Montu temple [NK18; minor MK11-12, Pt & R]	minor limestone; largely destroyed

Tod [Eg. Djerty; Gr. Tuphium]: EB at 25º 34.985' N, 32º 32.012' E	Montu temple [NK18 & Pt; minor MK11-12, NK19-20 & R]	largely destroyed
Esna [Eg. Iunyt, Senet and Tasenet; Gr. Latopolis]: on WB at 25º 17.609' N, 32º 33.371' E	Khnum temple [Pt-R]	intact
near Esna: (1) on WB at ~25º 19.3' N, 32º 31.6' E; (2) on EB at ~ 25º 17.1' N, 32º 34.9' E; (3) on WB at ~ 25º 12.8' N, 32º 38.0' E; (4-5) on WB but not located	(1) Khunum temple at Kom el-Deir [Pt-R]; (2) el-Hilla or Contralatopolis temple [Pt-R]; (3) Kom Mer temple [R]; (4) Osiris and Isis temple at Kom Senum [age?]; and (5) Sahure temple [OK5]	all destroyed and now lost with the building stone unknown, except for the el-Hilla temple, but probably sandstone
el-Kab [Eg. Nekheb; Gr. Eileithyiaspolis]: on EB at 25º 7.130' N, 32º 47.870' E	Nekhbet and Thoth temples [NK18-19, LP25-27, LP29-30 & R]	largely destroyed
near el-Kab: on EB at (1) 25º 8.313' N, 32º 49.718' E; (2) 25º 8.062' N, 32º 49.060' E; (3) 25º 8.021' N, 32º 49.089' E; (4) 25º 7.672' N, 32º 47.633' E; (5) 25º 7.318' N, 32º 48.054' E	(1) Hathor and Nekhbet shrine [NK18]	intact
	(2) Shesmetet shrine [Pt; minor NK19]	partly rock-cut; moderately intact
	(3) el-Hammam shrine [NK19; minor Pt]	intact
	(4) Thutmose III shrine [NK18]	destroyed
	(5) Nectanebo I or II shrine [LP30]	largely destroyed
Kom el-Ahmar [Eg. Nekhen; Gr. Hierakonpolis]: on WB at ~25º 5.86' N, 32º 46.84' E	temple [NK18; minor Pt]	minor limestone ?; destroyed
near el-Kilh Sharq: on EB, not located but near 25º 3.6' N, 32º 52.4' E	two temples [Pt or R like the nearby Nag el-Dumariyya quarry?]	both destroyed and now lost with the building stone unknown but probably sandstone
Edfu [Eg. Djeba or Mesen; Gr. Apollinopolis]: on WB at 24º 58.680' N, 32º 52.410' E	Horus temple [Pt; minor NK19-20]	intact
Nag el-Goneima: on WB at 24º 56.619' N, 32º 50.515' E	pyramid [ED3]	largely intact
Gebel el-Silsila [Eg. Kheny or Khenu]: on EB at 24º 38.991' N, 32º 56.045' E	Kheny temple [NK18-19]	minor limestone; destroyed
Rasras or **Faris**: on WB at 24º 35.205' N, 32º 54.086' E	temple [R]	destroyed
Kom Ombo [Eg. Nubt; Gr. Ombos]: on EB at 24º 27.120' N, 32º 55.690' E	Sobek and Haroeris temple [Pt; minor NK18 & R]	largely intact

Aswan area [Eg. Swenet; Gr. Syene]: on Elephantine Island (1) at 24º 5.095' N, 32º 53.177' E; (2) at 24º 5.086' N, 32º 53.199' E; (3) at 24º 5.054' N, 32º 53.187' E; in Aswan city (4) at 24º 5.042' N, 32º 53.601' E; on Philae Island (5) originally at 24º 1.300' N, 32º 53.336' E and moved to Agilkia Island at 24º 1.519' N, 32º 53.054' E; on Biga Island (6) at ~24º 1.25' N, 32º 53.16' E	(1) Hekaib shrine [MK11-12]	largely intact
	(2) Satet or Satis temple [MK11 & NK18]	moderately intact
	(3) Khnum temple [LP30]	largely destroyed
	(4) Isis temple [Pt]	intact
	(5) Isis temple complex [Pt-R; minor LP30]	intact
	(6) Osiris temple [Pt]	largely destroyed
Dabod: originally on WB at ~23º 53.7' N, 32º 51.7' E and moved to the Museo Arqueologico Nacional, Madrid, Spain	Isis temple [Mer & Pt-R]	largely intact
Dimri: on both WB and EB close to ~ 23º 51.2' N, 32º 53.5' E	temples [R]	largely destroyed and now under Lake Nasser
Qumla: on EB at ~23º 42.9' N, 32º 54.0' E	temple [Pt]	destroyed and now under Lake Nasser
Qertassi [Gr. Tzitzis]: originally on WB at ~23º 41.8' N, 32º 53.4' E and moved to New Kalabasha on WB at 23º 57.610' N, 32º 52.053' E	Hathor shrine [R]	largely intact
Tafa [Gr. Taphis]: originally on WB at ~23º 38.2' N, 32º 52.3' E and moved to Rijksmuseum van Oudheden, Leiden, Netherlands	north temple [R]	intact; there is also reportedly a south temple that is largely destroyed and now under Lake Nasser
Beit el-Wali: originally on WB at ~23º 33.7' N, 32º 51.8' E and moved to New Kalabsha on WB at 23º 57.710' N, 32º 51.976' E	Amun temple [NK19]	partly rock-cut; largely intact
Kalabsha [Gr. Talmis]: originally on WB at ~23º 33.6' N, 32º 51.8' E and moved to (1) New Kalabsha on WB at 23º 57.651' N, 32º 52.044' E; (2) 23º 57.646' N, 32º 52.002' E; (3) Elephantine Island at 24º 5.028' N, 32º 53.095' E; (4) Ägyptisches Museum, Berlin, Germany	(1) Horus-Mandulis temple [R]	largely intact
	(2) Dedwen shrine and birthhouse [Pt]	partly rock-cut; largely intact
	(3) Ptolemy IX shrine [Pt; minor R]	partly intact
	(4) gateway for Kalabsha temple enclosure [Pt-R]	largely intact
Abu Hor or **Kobash**?: on EB at ~ 23º 26.5' N, 32º 54.8' E	temple [Pt-R]	largely destroyed and now under Lake Nasser
Dendur [Gr. Tutzis]: originally on WB at ~ 23º 23.2' N, 32º 56.1' E and moved to Metropolitan Museum of Art, New York, USA	Pediset and Pihor temple [R]	intact
Gerf Hussein: originally on WB at ~23º 16.7' N, 32º 53.6' E with the free-standing courtyard moved to New Kalabsha on WB at 23º 57.617' N, 32º 52.017' E and portions of the rock-cut reliefs moved to the Aswan Museum	Ptah, Ptah-Tenen and Hathor temple [NK19]	partly rock-cut; largely intact with rock-cut portion now under Lake Nasser

el-Dakka [Eg. Pselqet; Gr. Pselchis]: originally on WB at ~23° 10.4' N, 32° 45.3' E and moved to New Sebu'a on WB at 22° 48.066' N, 32° 32.749' E	Thoth and Pnubs temple [Mer, Pt-R; some reused blocks from a MK-NK temple from other side of river]	intact
Kubban or **Quban** [Eg. Baki; Contra Pselchis]: on EB near ~23° 9.5' N, 32° 45.6' E	three temples [MK]	destroyed and now under Lake Nasser
Qurta: on WB at ~23° 6.6' N, 32° 43.1' E	Isis temple [R; minor NK18]	largely destroyed and now under Lake Nasser
el-Maharraqa or **Offeduniya** [Gr. Hierasykaminos]: originally on WB at ~23° 3.5' N, 32° 41.6' E and moved to New Sebu'a on WB at 22° 48.037' N, 32° 32.857' E	Serapis temple [R]	largely intact
es-Sebu'a: originally on WB at ~22° 46.0' N, 32° 33.5' E and moved to New Sebu'a on WB at 22° 47.579' N, 32° 32.723' E	Amun and Re-Horakhti temple [NK19; minor NK18]	partially rock-cut; largely intact
el-\`Amada: originally on WB at ~22° 43.4' N, 32° 14.3' E and moved to New Amada on WB at 22° 43.863' N, 32° 15.758' E	Amun and Re-Horakhti temple [NK18-19]	intact
\`Aniba [Eg. Mi'an]: on WB at ~ 22° 42.8' N, 32° 4.2' E	Horus or Karanub temple [NK18; minor MK12 & NK19-20]	largely destroyed and now under Lake Nasser
Kharaba: on EB near Nag Shaqqa at ~22° 38.9' N, 32° 16.1' E	temple [age?]	destroyed and now under Lake Nasser
Qasr Ibrim [Gr. Primis]: on EB at 22° 38.977' N, 31° 59.554' E	temple [LP25]	largely destroyed and now on an island in Lake Nasser
Faras [Gr. Pakhoras]: on WB at ~ 22° 13.0' N, 31° 29.0' E	Hathor temple [NK18]	largely destroyed and now under Lake Nasser
Aksha or **Serra West**: on WB at ~ 22° 9.6' N, 31° 25.0' E with some reliefs moved to the National Museum, Khartoum, Sudan	Amun-Re temple [NK19]	largely destroyed and now under Lake Nasser
Buhen: on WB at ~ 21° 54.4' N, 31° 17.2' E and moved to the National Museum, Khartoum, Sudan	Isis and Min temple [NK18] and Horus temple [NK18 & LP25]	largely intact
Behar & **Kor**: on WB at ~ 21° 52.6' N, 31° 15.6' E	Behar temple and Kor fortress walls [MK12-13]	largely destroyed and now under Lake Nasser
Mirgissa [Eg. Iken]: on WB at ~21° 49.5' N, 31° 11.7' E	Hathor temple [NK]	largely intact? and now under Lake Nasser
Semna West: originally on WB at ~21° 29.6' N, 30° 57.5' E and moved to the National Museum, Khartoum, Sudan	Dedwen temple [NK18 & LP25; minor MK12]	largely intact
Semna East or **Kumma**: originally on EB at ~21° 29.5' N, 30° 57.9' E and moved to the National Museum, Khartoum, Sudan	Khnum temple [NK18]	largely intact
\`Amara West: on WB at 20° 49.299' N, 30° 23.071' E	Amun temple [NK19]	largely destroyed

Sedeinga: on WB at 20º 33.181' N, 30º 17.623' E	Hathor temple [NK18]	destroyed
Soleb: on WB at 20º 26.179' N, 30º 20.043' E	Amun-Re temple [NK18]	largely destroyed
Sesebi: on WB at 20º 6.575' N, 30º 32.585' E	Aten temple [NK18] rebuilt as Amun, Mut and Khonsu temple [NK19]	largely destroyed
Tabo: on EB at 19º 23.141' N, 30º 28.161' E	Amun temple [LP25; minor Mer]	largely destroyed
Kawa [Eg. Gematon]: on EB at 19º 7.390' N, 30º 29.817' E	Amun temples [NK18, LP25 & Nap-Mer]	largely destroyed
Nuri: on WB at 18º 33.894' N, 31º 54.946' E	pyramids [LP25 & Nap-Mer]	largely intact
Jebel Barkal [Ku. Napata]: on EB at 18º 32.094' N, 31º 49.817' E	Amun temple complex [NK18-19, LP25 & Nap-Mer] and pyramids [Mer]	temples partly intact and pyramids intact
Sanam Abu Dom: on WB at 18º 29.004' N, 31º 49.139' E	Amun-Re temple [LP25]	largely destroyed
el-Kurru: on EB at 18º 24.546' N, 31º 46.243' E	pyramids [LP25]	largely destroyed
Western Desert		
Faiyum Depression: (1) Qasr el-Sagha at 29º 35.708' N, 30º 40.671' E; (2) Dimai [Gr. Soknopaiou Nesos] at 29º 32.150' N, 30º 40.115' E; (3) Medinet Madi [Gr. Narmouthis] at 29º 11.620' N, 30º 38.520' E	(1) temple [MK12]	intact
	(2) Soknopaios temple [Pt-R]	mostly mud brick and limestone; largely intact
	(3) Renenutet temple [MK12; minor Pt-R]	possibly sandy limestone; largely intact
Bahariyya Depression: in Bawiti area (1) at 28º 21.416' N, 28º 50.787' E; (2) at ~ 28º 21.25' N, 28º 51.50' E; (3) el-Qasr or `Ain el-Muftalla at 28º 20.870' N, 28º 51.502' E; (4) Qasr el-Migysbah at 28º 20.510' N, 28º 49.326' E; south of Bawiti (5) Qasr Allam at 28º 15.575' N, 28º 47.045' E	(1) Apries Shrines [LP26]	largely intact
	(2) Roman arch	destroyed
	(3) Amasis and Apries temple [LP26]	largely destroyed
	(4) Alexander the Great temple [Pt]	largely intact
	(5) Alexander the Great temple [Pt]	mostly mud brick; largely destroyed
Kharga Depression: (1) Ain Amur at 25º 39.112' N, 29º 59.460' E; (2) el-Kharga at 25º 28.587' N, 30º 33.316' E; (3) Kom el-Nadura at 25º 28.140' N, 30º 33.840' E; (4) Qasr el-Ghueida at 25º 17.200' N, 30º 33.470' E; (5) Qasr Zaiyan at 25º 15.085' N, 30º 34.254' E; (6) Qasr Dush at 24º 34.800' N, 30º 43.030' E	(1) temple [R]	partly limestone; largely destroyed
	(2) Hibis temple [LP27, LP30 & Pt]	minor limestone; largely intact
	(3) temple [R]	largely destroyed
	(4) Amun temple [LP26 & Pt]	largely intact
	(5) Amun, Mut and Khonsu temple [Pt-R]	largely intact
	(6) Isis and Serapis temple [R]	largely intact

Dakhla Depression: (1) el-Qasr el-Dakhla at ~25^{o} 41.79’ N, 28^{o} 53.01’ E; (2) Amheida at ~ 25^{o} 40.13’ N, 28^{o} 52.25’ E; (3) Deir el-Hagar at 25^{o} 39.882’ N, 28^{o} 48.800’ E; (4) Balat at 25^{o} 33.433’ N, 29^{o} 16.788’ E; (5) Ain Birbiya at 25^{o} 31.363’ N, 29^{o} 19.173’ E; (6) Ismant el-Kharab [Gr. Kellis] at 25^{o} 30.964’ N, 29^{o} 5.643’ E; (7) Mut el-Kharab at ~25^{o} 29.02’ N, 28^{o} 58.42’ E	(1) Thoth temple [Pt-R]	destroyed or buried under houses
	(2) Toth temple [Pt-R]	largely destroyed
	(3) Amun, Mut and Khonsu temple [R]	largely intact
	(4) Mut temple [NK]	largely destroyed
	(5) Amennakht temple [R]	possibly limestone; largely intact
	(6) Tutu and Neith temples [R]	possibly limestone; largely destroyed
	(7) Seth temple [R; minor NK18, 3IP, LP26 & Pt]	destroyed
Eastern Desert and Sinai		
Serabit el-Khadim, Sinai at 29^{o} 2.213’ N, 33^{o} 27.560’ E	Hathor temple [MK12 & NK18]	mostly limestone; largely intact
Bir el-Kanayis, Eastern Desert at 25^{o} 0.358’ N, 33^{o} 18.018’ E	Amun-Re temple [NK19]	mostly rock-cut

Appendix 2. Ancient Egyptian sandstone quarries[34]

LOCATION[35]	AGE[36], SIZE[37] and STATUS	SANDSTONE PETROLOGY[38]
Nile Valley		
Duwi Formation		
el-Mahamid on EB at 25º 8.15' N, 32º 46.92' E	Pt; medium; intact and not protected?	very fine- to fine-grained; massive to indistinct planar bedding with minor tabular cross-bedding; light yellowish-brown (total feldspar = 9.4-11.2% [2])
Shesmetet on EB at 25º 8.065' N, 32º 49.034' E	NK19 & Pt like the nearby Shesmetet temple?; small; intact and protected	fine-grained; massive to indistinct planar bedding with minor tabular cross-bedding; light brown?
Wadi el-Tarifa on WB at 25º 4.70' N, 32º 44.62' E	NK18 & Pt like the nearby Kom el-Ahmar temple?; medium; destroyed	very fine- to medium-grained; massive bedding to tabular cross-bedding; light brown to mainly light brownish gray or light gray (has a "high proportion of feldspar" according to Klemm and Klemm 2008: 173)
el-Keijal on EB at 25º 4.09' N, 32º 51.78' E	Pt or R, at least in part; small; intact and not protected	very fine- to fine-grained; massive bedding; medium brown or light pinkish to purplish brown (total feldspar = 8.7% [1])
Quseir Formation – upper part		
Nag el-Dumariyya on EB at 25º 2.96' N, 32º 53.33' E	Pt-R; small, intact and not protected	very fine- to fine-grained; planar bedding with minor trough cross-bedding; light pinkish gray or brown
el-Bueib on EB at 24º 48.61' N, 32º 54.84' E	MK12, NK18 & B?; medium; moderately intact and not protected	very fine- to medium-grained; massive to planar bedding and tabular cross-bedding; light brown (total feldspar = 6.1% [1])
Nag el-Raqiqein WB at 24º 44.76' N, 32º 55.24' E	age?; small; largely intact and now threatened	very fine- to mainly fine-grained; tabular cross-bedding with minor planar bedding; light to medium brown (total feldspar = 14.2% [1])
Quseir Formation – lower part		
Nag el-Hosh on WB at 24º 44.31' N, 32º 55.28' E	Pt-R; medium; largely intact and now threatened	fine- to mainly medium-grained; tabular cross-bedding; light brown to light pinkish-brown (total feldspar = 1.4% [1])

34 This data comes primarily from the author's unpublished field and laboratory studies. Additional information is provided by (1) Klemm and Klemm (1993), pp. 225-281; (2008), pp. 167-213 for quarries in the Nile Valley north of Aswan and in the Western Desert's depressions; and (2) Spence *et al.* (2009), pp. 44-45 and Mohamed (2012) for quarries in the Nile Valley south of Wadi Halfa in Sudan.

35 Coordinates are for quarry centers. Where there is uncertainty in a location, this is indicated by the approximate symbol (~) and a reduced precision in the reported coordinates.

36 See footnote 33 in Appendix 1.

37 Quarry size corresponds to the maximum dimension of an area of workings or the cumulative maximum dimensions for multiple isolated areas of workings. Three size classes are recognized: small (< 100 m), medium (100-1000 m), and large (> 1000 m).

38 The Udden-Wentworth scale is used for grain size, and colors are for internal (fresh) surfaces. The number of samples analyzed is indicated within brackets for total feldspar content.

Wadi Shatt el-Rigal on WB at 24° 41.11' N, 32° 55.39' E	MK11-12 & NK18?; medium; intact and partially protected	very fine- to mainly fine- to medium-grained; tabular cross-bedding; light gray to light yellowish gray or brown (total feldspar = <1% [1])
Nag el-Hammam on WB at 24° 40.36' N, 32° 55.47' E	MK-NK?; medium; intact and not protected	very fine- to mainly fine- to medium-grained: tabular cross-bedding; light brown (northern part) to brownish-yellow (southern part) with occasional thin purplish-brown planar zones (total feldspar = <1% [4])
Gebel el-Silsila on WB at 24° 39.05' N, 32° 55.75' E, and on EB at 24° 38.48' N, 32° 56.04' E	MK-R; large; largely intact and protected	mainly fine- to medium-grained and occasionally pebbly medium- to coarse-grained; tabular cross-bedding but planar bedding when coarse-grained; light to medium brown or yellowish- to orangy-brown with common minute reddish-brown spots, or yellowish-white to white (total feldspar = <1.3% [6])
Umm Barmil Formation		
Nag el-Falilih on EB at 24° 20.04' N, 32° 55.27' E	Pt & R?; medium; partially destroyed and not protected	very fine- to mainly fine-grained; massive to indistinct tabular cross-bedding; light yellowish- to pinkish-brown (total feldspar = 3.5% [1])
Nag el-Sheikh Garad on EB at 24° 18.45' N, 32° 54.72' E	Pt & R?; large; largely destroyed	very fine- to mainly fine- to medium-grained; tabular cross-bedding; light yellowish- to pinkish-brown (total feldspar = 1.5-4.6% [3])
Gebel el-Hammam on EB at ~24° 13.5' N, 32° 52.5' E	NK18; small?; destroyed	very fine- to mainly fine- to medium-grained; tabular cross-bedding; light yellowish- to pinkish-gray (total feldspar = 1.7% [1])
Nag el-Fuqani on WB at 24° 12.24' N, 32° 51.60' E	Pt; medium; largely intact and now threatened	fine- to medium-grained; tabular cross-bedding with minor planar to wavy bedding; yellowish- or pinkish-gray to mainly light gray
Hagar el-Ghorab on WB at 24° 11.33' N, 32° 51.79' E	Pt-R?; small; intact and now threatened	no information
Gebel el-Qurna WB at 24° 9.75' N, 32° 52.10' E	R and earlier?; medium; intact and not protected	fine- to mainly medium- to coarse-grained; tabular cross-bedding; light gray or light yellowish- to pinkish-gray (total feldspar = <1% [2])
Timsah Formation		
Qubbet el-Hawa on WB at 24° 6.11' N, 32° 53.26' E (possible quarry)	from exteriors of OK6 & MK12 tombs; small; intact and protected	medium- to mainly fine-grained; planar bedding with thin mudstone interbeds; light gray or multi-hued in shades of gray, yellow, brown, red and purple
Abu Aggag Formation		

St. Simeon on WB at 24° 5.69' N, 32° 52.55' E	either OK-MK like the nearby Qubbet el-Hawa tombs or B like the St. Simeon monastery; small; largely intact and protected	medium- to coarse-grained; planar bedding; light brown?
Aswan on EB at 24° 3.29' N, 32° 54.46' E	NK & R?, medium?; largely destroyed	no information
Dabod on WB at ~23° 53.7' N, 32° 51.7' E	Pt, R & Mer like the nearby Dabod and Dimri temples?; small?; under Lake Nasser	
Qertassi on WB at ~23° 41.8' N, 32° 53.4' E	Pt & R; large; under Lake Nasser	
Tafa on WB at ~23° 38.2' N, 32° 52.3' E	R like the nearby Tafa temple?; small or medium?; under Lake Nasser	
Kalabsha on WB at ~23° 33.6 ' N, 32° 51.8' E	Pt-R like the nearby Kalabsha temples; small or medium?; under Lake Nasser	fine-grained; light yellowish-brown – based on samples from the Kalabsha temple (total feldspar = <1 % [2])
Abu Hor on WB ~23° 26.5' N, 32° 54.8' E	Pt & R like the nearby Abu Hor temple?; small or medium?; under Lake Nasser	no information
Sabaya Formation		
Qurta on WB at ~23° 6.6' N, 32° 44.1' E	MK, NK18, Pt & R like the nearby Kubban, el-Dakka, Qurta and el-Maharraqa temples?; small or medium?; under Lake Nasser	fine-grained; light brown to yellowish-brown – based on samples from the el-Maharraqa temple (total feldspar = <1% [4])
Agayba on WB at ~22° 51.0' N, 32° 34.0' E	NK18-19 like the nearby es-Sebu'a temple; small?; under Lake Nasser	no information
Sabaya or Lake Nasser Formation		
Tumas on WB at ~22° 45.4' N, 32° 7.0' E	MK12 & NK18-19 like the nearby el-`Amada and `Aniba temples?; small or medium?; under Lake Nasser	no information
Lake Nasser Formation		
Qasr Ibrim on EB at ~ 22° 39.0' N, 31° 59.5' E	LP25 like the nearby Qasr Ibrim temple?; small?; under Lake Nasser	no information
Nag Deira on EB at ~22° 30.4' N, 31° 53.5' E	NK like the nearby rock-cut tombs?; small; under Lake Nasser	
Gebel Adda on EB at ~ 22° 17.7' N, 31° 36.5' E	Mer; small; under Lake Nasser	pink and white sandstones; no other information
Abu Simbel Formation		
Gezira Dabarosa on WB at ~21° 55.8' N, 31° 18.7' E	MK12-13, NK18 & LP25 like the nearby Buhen and Kor fortresses?; small; under Lake Nasser	no information
Abdel Kadir on WB at 21° 52.41' N, 31° 9.13' E	MK11; small; intact and above Lake Nasser	

Nubian Sandstone Formation undifferentiated		
Sesebi on WB at 20° 6.70' N, 30° 32.57' E	NK18-19 like the nearby Sesebi temple?; small; intact and unprotected?	cross-bedded; light gray to nearly white with occasional orange bands; no other information
Jebel Barkal Foug on EB at 18° 32.66' N, 31° 49.86' E	NK18-19, LP25, Nap & Mer like the nearby Gebel Barkal temples?; small to medium; largely intact and not protected	no information
Khor el-Hawazawin on EB at 18° 30.59' N, 31° 48.58' E		
Khor el-Sadda on EB at 18° 30.05' N, 31° 48.08' E		
Eastern Desert		
el-Muweih at 25° 56.70' N, 33° 23.91' E	R; medium; intact and not protected	Taref Formation: no other information
Bir el-Kanayis at 25° 0.24' N, 33° 18.52' E	NK19 & R like the nearby temple and praesidium?; small; intact and protected	Quseir Formation: no other information
Western Desert		
Qaret el-Farangi, Bahariya Depression at ~28° 20.69' N, 28° 51.92' E	LP26, Pt & R like the nearby temples in el-Bawati?; small?; largely destroyed?	Bahariya Formation: no other information
el-Muzawqa, Dakhla Depression at 25° 40.91' N, 28° 50.31' E	Pt & R like the nearby Amheida and Deir el-Hagar temples?; small; intact and protected?	Quseir or Duwi Formation: no other information
south of Masara, Dakhla Depression at ~25° 28.7' N, 29° 3.4' E	NK18, 3IP, LP26, Pt & especially R like the nearby Ismant el-Kharab and Mut el-Kharab temples?; medium?; largely intact and not protected	Quseir or Taref Formation: no other information
Gebel el-Teir, Kharga Depression at ~25° 32.4' N, 30° 33.1' E	LP27, LP30, Pt & R like the nearby el-Kharga and Kom el-Nadura temples?; small?; largely intact?	Quseir or Dakhla Formation: no other information
Sinai Peninsula		
Serabit el-Khadim at 29° 2.20' N, 33° 23.90' E	MK12-NK20 like the nearby Hathor temple	Abu Durba Formation of Lower Carboniferous age

Bibliography

Ahmed, S. M., Al-Sheikh, H. A. and Osman, R. A. (1993), 'Facies and depositional environments of the pre-Maastrichtian clastic rocks of west and southwest Aswan, Egypt', *Egyptian Journal of Geology* 37/2, pp. 69-96.

Ahmed, M. I. S. and Hussein, S. A. (1983), 'Petrophysical properties of some sandstones facies from EL-Mahamid, Eastern Desert, Egypt', *Egyptian Journal of Geology* 27/1-2, pp. 21-26.

Arnold, D. (1979), *The Temple of Mentuhotep at Deir El-Bahari*, New York: Metropolitan Museum of Art, Egyptian Expedition.

Arnold, D. (1991), *Building in Egypt: Pharaonic Stone Masonry*, Oxford: Oxford University Press.

Attia, M. I. (1955), *Topography, Geology and Iron-Ore Deposits of the District East of Aswan*, Cairo: Egyptian Geological Survey.

Baedeker, K. (1929), *Egypt and the Sudan – Handbook for Travelers* (8th ed.), Leipzig: Karl Baedeker Publisher.

Baines, J. and Malek, J. (2000), *Cultural Atlas of Ancient Egypt*, Oxford: Andromeda/Checkmark Books.

Baioumy, H. M. (2007), 'Iron-phosphorus relationship in the iron and phosphorite ores of Egypt', *Chemie der Erde* 67, pp. 229-239.

Baioumy, H. M. and Boulis, S. N. (2012a), 'Glauconites from the Bahariya Oasis: an evidence for Cenomanian marine transgression in Egypt', *Journal of African Earth Sciences* 70, pp. 1-7.

Baioumy, H. M. and Boulis, S. N. (2012b), 'Non-pelletal glauconite from the Campanian Qusseir Formation, Egypt: implications for glauconitization', *Sedimentary Geology* 249/250, pp. 1-9.

Breasted, J. H. (1906), *Ancient Records of Egypt – Historical Documents*, Vol. 4, *The Twentieth to the Twenty-Sixth Dynasties*, Chicago: University of Chicago Press.

Clarke, S. (1910), 'Architectural descriptions', in E. Naville (ed.), *The XIth Dynasty Temple at Deir El-Bahari* (pt. 2), London: Egypt Exploration Fund, pp. 13-19.

Clarke, S. and Engelbach, R. (1930), *Ancient Egyptian Masonry – The Building Craft*, London: Oxford University Press.

Description de l'Égypte. (1809-1829), *Description de l'Égypte, ou Recueil de observations et des recherches qui ont été faites en Égypte pendant l'éxpédition de l'armée française*, Paris: C. L. F. Panckoucke.

Fakhry, A. (1973-74), *The Oases of Egypt*, Vol. 2, *Bahriyah and Farafra Oases*, Cairo: American University in Cairo Press.

Fitzner, B., Heinricks, K. and La Bouchardiere. D. (2003), 'Weathering damage on pharaonic sandstone monuments in Luxor, Egypt', *Building and Environment* 38/9-10, pp. 1089-1103.

Ghanem, M., Zalata, A., Abd El Razik, T., Mikhailov, I., Mirtov, J., Razvaliaev, A. and Touliankin, V. (1968), *Geological Map of Idfu-Qena Area* (1:200,000; with accompanying stratigraphic column and cross-sections), Cairo: United Arabic Republic General Organization for Geological Researches and Mining Geological Survey.

Glenn, C. R. (1990), 'Depositional sequences of the Duwi, Sibaiya and Phosphate Formations, Egypt: phosphogenesis and glauconitization in a Late Cretaceous Sea', in A. J. G. Notholt and I. Jarvis (eds.), *Phosphorite Research and Development*, London: Geological Society (Special Publication No. 52), pp. 205-222.

Glenn, C. R. and Arthur, M. A. (1990), 'Anatomy and origin of a Cretaceous phosphorite-greensand giant, Egypt', *Sedimentology* 37, pp. 123-154.

Gohary, J. (1998), *Guide to Nubian Monuments on Lake Nasser*, Cairo: American University in Cairo Press.

Harrell, J. A. (2012a), 'Building stones', in W. Wendrich (ed.), *UCLA Encyclopedia of Egyptology*, Los Angeles: University of California at Los Angeles. [online at http://digital2.library.ucla.edu/viewItem.do?ark=21198/zz002c10gb]

Harrell, J. A. (2012b), 'Ornamental stones', in W. Wendrich (ed.), *UCLA Encyclopedia of Egyptology*, Los Angeles: University of California at Los Angeles. [online at http://digital2.library.ucla.edu/viewItem.do?ark=21198/zz002dwzs4]

Harrell, J. A. (2012c), 'Utilitarian stones', in W. Wendrich (ed.), *UCLA Encyclopedia of Egyptology*, Los Angeles: University of California at Los Angeles. [online at http://digital2.library.ucla.edu/viewItem.

do?ark=21198/zz002bqsfg]

Harrell, J. A., and Madbouly, M. I. (2006), 'An ancient quarry for siliceous sandstone at Wadi Abu Aggag, Egypt', *Sahara* 17, pp. 51-58.

Harrell, J. A., and Storemyr, P. (2013), 'Limestone and sandstone quarrying in ancient Egypt: tools, methods, and analogues', *Marmora* 9, pp. 19-43.

Heldal, T., Bloxam, E., Storemyr, P. and Kelany, A. (2005), 'The geology and archaeology of the ancient silicified sandstone quarries at Gebel Gulab and Gebel Tingar, Aswan (Egypt)', *Marmora* 1, pp. 11-35.

Hermina, M., Klitzsch, E. and List, F. K. (1989), *Stratigraphic Lexicon and Explanatory Notes to the Geological Map of Egypt* (1:500,000, 20 sheets), Cairo: Egyptian General Petroleum Corporation and Conoco Coral.

Hölscher, U. (1939), *The Excavation of Medinet Habu*, Vol. 2, *The Temples of the Eighteenth Dynasty*, Chicago: University of Chicago Press.

Issawi, B., El Hinnawi, M., Francis, M. and Mazhar, A. (1999), *The Phanerozoic Geology of Egypt – A Geodynamic Approach*, Cairo: Egyptian Geological Survey (Special Publication No. 76).

Kitchen, K. A. (1991), 'Building the Ramesseum', *Cahiers de Recherches de l'Institut de Papyrologie et d'égyptologie de Lille* 13, pp. 85-93.

Klemm, R. and Klemm, D. D. (1993), *Steine und Steinbrüche im Alten Ägypten*, Berlin: Springer-Verlag.

Klemm, R. and Klemm, D. D. (2008), *Stones and Quarries in Ancient Egypt*, London: British Museum Press.

Klemm, D. D., Klemm, R. and Steclaci, L. (1984), 'Die pharaonischen steinbrüche des silifizierten sandsteins in Ägypten und die herkunft der Memnon-Kolosse,' *Mitteilungun des Deutschen Archäologischen Instituts Abteilung Kairo* 40, pp. 207-220.

Klitzsch, E., List, F. K. and Pöhlmann, G. (eds.) (1987), *Geological Map of Egypt* (1:500,000; 20 sheets), Cairo: Egyptian General Petroleum Corporation and Conoco Coral.

Knox, W. O., Stadelmann, R., Harrell, J. A., Heldal, T. and Sourouzian, H. (2009), 'Mineral fingerprinting of Egyptian siliceous sandstones and the quarry source of the Colossi of Memnon', in N. Abu Jaber, E. G. Bloxam, P. Degryse and T. Heldal (eds.), *QuarryScapes: Ancient Stone Quarry Landscapes in the Eastern Mediterranean*, Bergen: Geological Survey of Norway (Special Publication no. 12), pp. 75-83.

Kramer, A. H. (2009), 'Talatat shipping from Gebel el-Silsileh to Karnak – a literature survey', *Bibliotheca Orientalis* 66/1-2, pp. 6-20.

Larché, F. (2009), 'A reconstruction of Senwosret I's portico and of some structures of Amenhotep I at Karnak', in P. J. Brand and L. Cooper (eds.), *Causing His Name to Live – Studies in Egyptian Epigraphy and History in Memory of William J. Murnane*, Leiden: Brill, pp. 137-173.

Lucas, A. (1905), *The Blackened Rocks of the Nile Cataracts and of the Egyptian Deserts*, Cairo: Ministry of Finance.

Marouard, G. and Papazian, H. (2012), 'The Edfu Pyramid Project: recent investigation at the last provincial step pyramid', *The Oriental Institute News and Notes* 213, pp. 3-9.

Mohamed, A. A. (2012), 'Quarrying for the king – the sources of stone for Kushite royal monuments', *Sudan & Nubia* 16, pp. 2-7.

Murnane, W. J. (1996), *The Penguin Guide to Ancient Egypt*, New York: Penguin Books.

Petrie, W. M. F. (1903), *Abydos* (Pt. 2), London: Egypt Exploration Fund.

Petrie, W. M. F. (1938), *Egyptian Architecture*, London: British School of Archaeology in Egypt.

Potter, R. and Rossman, G. (1977), 'Desert varnish: the importance of clay minerals', *Science* 196, pp. 1446-1448.

Potter, R. and Rossman, G. (1979), 'The manganese- and iron-oxide mineralogy of desert varnish', *Chemical Geology* 25, pp. 79-94.

Quibell, J. E. and Green, F. W. (1902), *Hierakonpolis* II, London: Bernard Quaritch.

Seton-Williams, V. and Stocks, P. (1988), *Blue Guide – Egypt*, London: A. & C. Black.

Shaw, I. and Jameson, R. (1993), 'Amethyst mining in the Eastern Desert: a preliminary survey at Wadi el-Hudi', *Journal of Egyptian Archaeology* 79, pp. 81-97.

Shukri, N. M. and Ayouti, M. K. (1953), 'The mineralogy of the Nubian Sandstone in Aswan', *Bulletin de l'Institut Désert de Égypt* 3/2, pp. 65-88.

Spence, K., Rose, P., Bunbury, J., Clapham, A., Collet, P., Smith, G. and Soderbery, N. (2009), 'Fieldwork at Sesebi, 2009', *Sudan & Nubia* 13, pp. 38-46.

Van Houten, F. B. and Bhattacharyya, D. P. (1979), 'Late Cretaceous Nubia Formation at Aswan, Southeastern Desert, Egypt', *Annals of the Geological Survey of Egypt* 9, pp. 408-419.

Ward, W. C. and McDonald, K. C. (1979), 'Nubia formation of central Eastern Desert, Egypt: major subdivisions and depositional setting', *American Association of Petroleum Geologists Bulletin* 63, pp. 975-983.

Weigall, A. E. P. (1907), *A Report on the Antiquities of Lower Nubia (the First Cataract to the Sudan Border) and Their Condition in 1906-1907*, Oxford: Oxford University Press.

Weigall, A. E. P. (1910), *A Guide to the Antiquities of Upper Egypt, from Abydos to the Sudan Frontier*, New York: Macmillan Co.

Wilkinson, J. G. (1847), *Hand-book for Travellers in Egypt*, London: John Murray.

Wilkinson, R. H. (2000), *The Complete Temples of Ancient Egypt*, London: Thames and Thames.

JAEA 1, 2016, pp. 39-56. www.egyptian-architecture.com

Biography of a Great Pyramid Casing Stone

D. I. Lightbody[1]

In the collection of the National Museum of Scotland in Edinburgh is an unusual artefact; a block of limestone, roughly hewn and damaged in places, and weighing around half a metric ton. The stone is of remarkable historic and scientific significance. Around 2,600 B.C.[2] it was cut from the bedrock, shaped and sized in the *R3-3w*  quarries, now known as the Tura quarries (they are still accessible in the hills overlooking the east side of the Nile valley just south of modern day Cairo). The stone was then transported 15 km across the river valley to the largest pyramid ever built in Egypt, the Great Pyramid of pharaoh Khufu at Giza, where it was raised and placed on its outer face.

Incredibly, a written record of the journey these stones took to Giza has survived.[3] In 2013 fragments of a 4th Dynasty papyrus from the 26th or 27th year of the reign of pharaoh Khufu were recovered from the Wadi al-Jarf on the west coast of the Red Sea, where an Old Kingdom port is being excavated. The papyrus fragments that the joint Franco-Egyptian team[4] uncovered turned out to be the oldest ever found. Furthermore, the hieroglyphs written on one of them describe the transportation of stone blocks from the Tura quarries, across the Nile to the Pyramid of Khufu at Giza. As the high quality stone from the Tura quarry was reserved for use on the outer faces of the pyramids, the stones they described moving were surely casing blocks, and the stone in Edinburgh could therefore be one that was transported by the team described in the text.

The so-called 'Journal of Merer' on the papyrus dates from the end of Khufu's reign, when the casing stones were being added to the almost-complete pyramid. Merer was the leader of a 'phyle' of approximately 200 workers in a team called *M3-wrrt*, a name which remains enigmatic. The journal records the following events :[5]

> 'Day 26. Inspector Merer sailed with his team from Tura [south]; loaded with stones for the Horizon of Khufu;[6] passed the night at the Lake of Khufu.
>
> Day 27. Sailed from the Lake of Khufu; navigated to the Horizon of Khufu, loaded with stones; passed the night at the Horizon of Khufu.
>
> Day 28. Sailed from the Horizon of Khufu in the morning; navigated back up the river to Tura [south].
>
> Day 29. Inspector Merer spent the day collecting stones in Tura south; passed the night at Tura south.'

---

1 Ex University of Glasgow, Scotland and Co-Editor of the Journal of Ancient Egyptian Architecture.
2 Ramsay *et al.* (2010), p.1556.
3 See Tallet (2016) and P. Jarf I-III, and Tallet and Marouard (2014).
4 Led by Pierre Tallet of the University of Paris IV-La Sorbonne and Gregory Marouard of the Oriental Institute of Chicago.
5 Translation by the author from the French.
6 The ancient name of the Great Pyramid of Khufu translated into English.

The content of this papyrus then is a daily diary of work carried out by Inspector Merer and his team during the construction of the Great Pyramid of Giza. It describes events just like the ones that would have brought the Edinburgh stone to Giza. It is incredibly fortuitous to have recovered this papyrus, but information regarding the stone is not only derived from ancient texts. Archaeological information about the Ancient Egyptians and their construction methods can also be derived from examining the stone itself. The Ancient Egyptian monument on which it was placed and the tools and techniques they used to build it also provide valuable information about the Old Kingdom culture and the technologies it developed.

In April of 2013 I was able to carry out a study of the casing stone in Edinburgh with permission granted by National Museums Scotland.[7] That study yielded new data, new architectural information, and improved understanding of an issue of more profound cultural significance.

In this article I summarize the motivations of the man who had the stone brought to Edinburgh in 1872, Charles Piazzi Smyth, and critique his own analysis of the stone.[8] I show that when more appropriately investigated, the stone reveals significant information about its original position on the outside of the Great Pyramid, as well as information regarding the Ancient Egyptians' own systems of measurement. Finally, I address the symbolic significance of the principal dimensions of this stone, and the monument on which it was placed. I explain how the dimensions and proportions of the block and the building were most likely related to the geometric proportions of a circle, and I explain what this architectural symbolism would have meant to the Ancient Egyptians. This phenomenon was the issue which first attracted the English Egyptologist Flinders Petrie to study the architecture of Egypt and the Giza necropolis in particular. He addressed it at length in his report of his 1883 survey of Giza.[9] Here I offer additional explanation to clarify aspects of this long standing investigation.

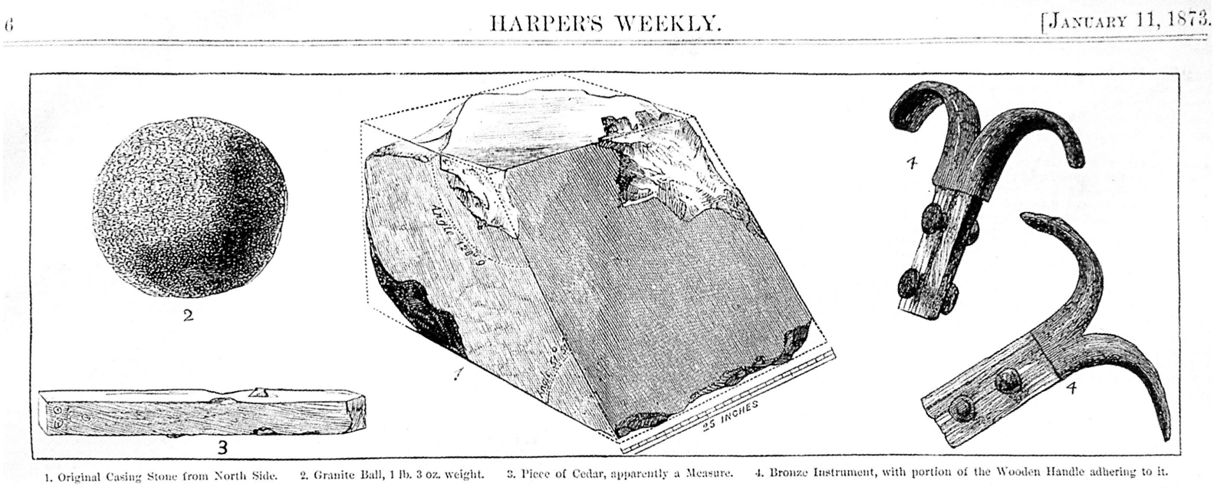


Fig. 1. The Casing stone illustrated in the 1873 *Harper's Weekly* article (January 11, 1873), along with tool artefacts. Public domain image.

---

7 Thanks to Margaret Maitland, curator of the Ancient Mediterranean at the National Museum of Scotland, and Alan Jeffreys, vice chair of Egyptology Scotland for help in completing this research project. This paper is dedicated to the members and committee of Egyptology Scotland which celebrates its 15th anniversary this year. Thanks also to Ghi Stecyk for help producing the illustrations, Franck Monnier for the animations on the website version, and my peer reviewers for their constructive feedback, which I have attempted to incorporate and respond to.

8 Smyth (1872), p. 489.

9 Petrie (1885), p. 93; Lightbody (2008).

The Giza Casing Stone

The casing stone addressed by this study is NMS collection museum catalogue number A.1955.176. We studied and took measurements of this piece in the museum storerooms in April 2013. Casing stones have an angled front face that formed the flat outer surface of the pyramids and I was interested to establish if its face slope matched the angles calculated elsewhere for the Great Pyramid of Giza, from the building itself, and from surviving casings stones. The casing stones are trapezoidal in form when viewed from the side, as opposed to core blocks which were most likely left roughly hewn and approximately cuboid.[10] If the slope of any casing stone's outer face is accurately known then the side slope of all of the pyramid's faces are known, and so these casing stones are of particular interest to archaeologists studying pyramid architecture, as was the case with Smyth and Petrie.

Fig. 2. The casing stone in the NMS stores, with the outer face orientated to the top of the image. Author's image.

Based on the type of limestone used and its associated architectural function, this casing block was most likely mined at the Tura quarries on the east side of the Nile around 46 centuries ago, carefully shaped with copper tools, shipped across the river to Giza on the west bank, dragged up to the pyramid construction site on a wooden sled, and lifted into place on the outside of the Old Kingdom pyramid of pharaoh Khufu using methods that remain obscure. Its outer face may have been worked again *in-situ* to ensure it was finished flush with the rest of the pyramid's external surface.

Forty-four centuries later, the stone was found in the mounds of debris on the north side of the Great Pyramid of Khufu by Waynman Dixon in 1872. Its original architectural position on the pyramid was unknown at the time it was collected from the site. Dixon was an English engineer who carried out investigative work at Giza for Charles Piazzi Smyth.[11] At the time, Smyth was Astronomer Royal for Scotland, based in Edinburgh, where he carried out research into many different scientific and historical issues.

---

10 This is impossible to verify as the vast majority of core blocks remain inaccessible.
11 Brück and Brück (1988).

Almost all of these casing stones were stripped off the pyramid in the ancient past as they were made from high quality stone and were useful for building the city of Cairo and for producing limestone mortar. Only a few oversized base level casing stones remain *in situ* at the Great Pyramid. The example in the NMS collection found by Waynman Dixon is not from the base level and is therefore unique in several respects.

Its arrival on the British Isles was reported in *Nature*, 26th December 1872, pp. 146-149, and *The Graphic* of 7th December 1872, pp. 530 and 545, where it was illustrated along with several other artefacts found in and around the Great Pyramid, including a stone ball, the remains of two copper tools, and a wooden shaft. Smyth published the stone's primary dimensions and an analysis of those dimensions, but he did not investigate the piece with respect to Ancient Egyptian standards, methods and systems, and so he reached no significant historical conclusions. Although large parts of the stone are broken off and missing, its overall rectilinear dimensions can be reconstructed from the surviving material, with a margin of error of +/- 5 mm, as follows:

65 cm wide
52 cm in height
93 cm from front to rear at the base
51 cm from front to rear on the top.

A large section of the back and lower rear face of the stone is broken away and so its approximate weight is calculated to be around 500 kg.

Although it remains in one solid piece, the casing stone is substantially chipped around the edges and corners, probably due to having been pushed down the pyramid in the ancient past. Three all-important worked flat faces are partially intact and in good condition in places, a fact that was also noted by Smyth. These three surfaces are the flat base, the sloped front face and the flat top. This means that fairly accurate measurement of its original, intended primary dimensions, and its intended slope angle, can be made; something that Smyth achieved and we were able to repeat.

Our angular measurements showed that within our margins of error (+/- 0.25°), the face of the stone, when compared to the upper and lower flat surfaces, and hence the horizon, is at the correct angle known for the Great Pyramid's faces, of around 51.84 degrees.[12] The limestone of the block is still surprisingly bright in color, almost silvery, particularly the limestone dust that has accumulated on the surface over time. The Tura limestone from south of Cairo is thought to have been utilized because it is a light colored stone suitable for the outer faces of monuments. These two facts; the slope angle and the geological material, indicate that the NMS stone is a genuine Giza casing stone, and is the same stone studied by Smyth over one hundred years ago.

Authentically sized standard cubit replicas were also used to measure the incline of the stone's face (Fig. 2). We simulated using the seked slope measuring method devised by the Ancient Egyptians themselves to check the face. The cubits were employed on the basis that practical experimental archaeology, using techniques from the ancient past, often reveals aspects of materials that otherwise remain hidden. During the Old Kingdom the Ancient Egyptian cubit standard was 52.37 cm long +/- 2 mm.[13] This value was very consistently maintained with only a couple of mil-

12 Lehner (1997), p. 17.

13 Petrie (1883), p. 179; Lauer (1931), p. 59. See also cubit values in Wilkinson (1841), pp. 24-34. Lepsius (2000) gives 0.525 m. See also Arnold (1991), p. 251. This value is derived from measuring parts of the finest structures built with lengths of multiples of cubits, and then subdividing the result by the assumed number of whole cubits that were intended by design. This is why a mean value can reasonably be quoted to a precision of less than 1 mm. It is not the length of any one rule or the precision of any one measurement. It is not known how this level of consistency was maintained in practice, but accurate limeters of variation, particularly when it was utilized to build monumental architecture during the Old Kingdom. The standard cubit was subdivided into 7 palms of 4 digits each, giving 28 digits in total. This cubit was known as the *mḥ nswt*, written as follows meaning the royal, pharaonic or official cubit.

The slope measurement system employed by the Ancient Egyptians was a 'rise and run' method known as the 'seked' system, written as follows *skd*. Textual evidence of the use of this system dates back to the Middle Kingdom. Angular slope measurement was made by measuring the linear horizontal offset, in palms, for each 1-cubit vertical rise. For example, a cubit has 7 palms, so a seked of 7 is 45 degrees.

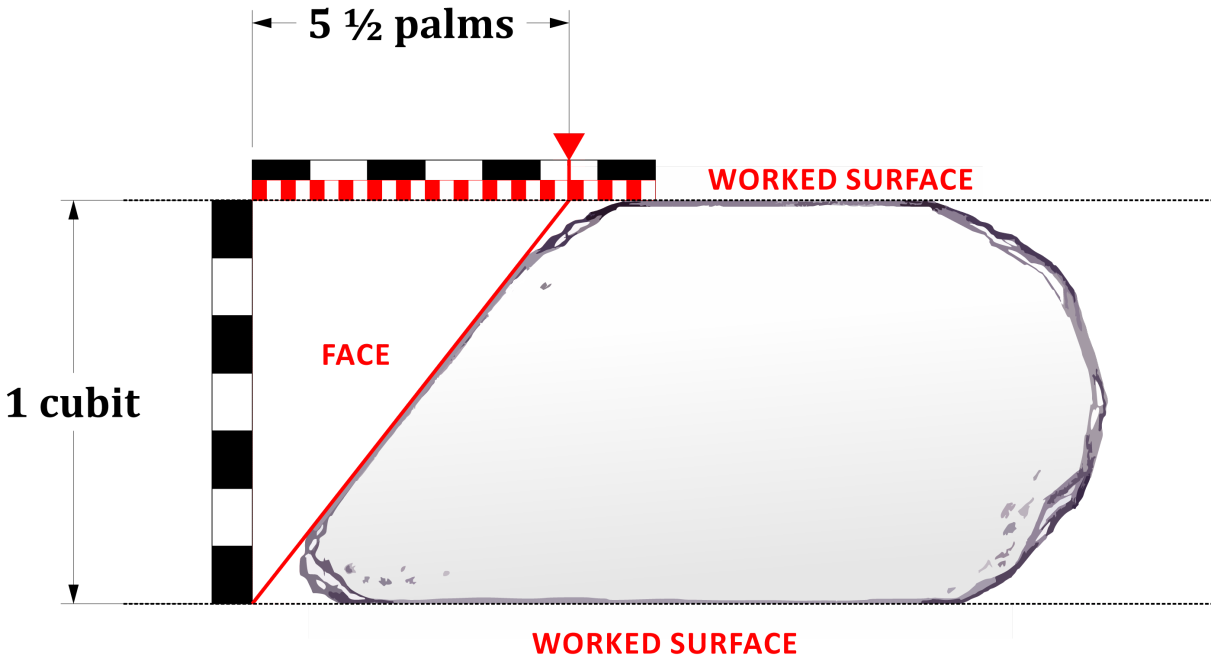


Fig. 3. Measurement of the seked slope of the block face using replica cubit rods.

The known seked of the Great Pyramid equates to 5 1/2 palms. Before we started the study this value was marked off on one cubit to be held along the horizontal top surface, while the other was to be set vertically, at right angles to the first. This formed a right angled triangle with a hypotenuse sloped at a seked of 5 1/2. This seked corresponds to 51.84 degrees from the horizontal, the known 'pyramid angle'. During this measurement it immediately became apparent that the triangle fitted the sloped face and the block precisely, not just in slope but in height, and so indicated that the casing stone was exactly 1 cubit thick in height, something that was not noted by Smyth (Fig. 3). Why did Smyth not notice this fundamental relationship ? Going by Smyth's publications

copying of fine reference rules may have been supplemented by the use of reference lengths of 10 or 20 cubits, marked out on the ground, against which rules were checked and re-checked and which did not vary. Such reference lengths and longer measuring rods of 10 or 20 cubits in length may have been used for setting out larger monuments. The close correspondence between the standard value derived from the dimensions of the 'king's chamber' and the ground plan of the Great Pyramid indicates that the Old Kingdom Egyptians were able to attain a level of accuracy equivalent to 1 part in 1000 using methods along these lines. In practice this meant that a mean accuracy of better than 1mm per cubit could be maintained in the highest quality cases, as seems to have been the case for the overall base side lengths of the Great Pyramid which vary by less than 70 mm over 440 cubits.

this was because he was pre-occupied with the width of the stone, from side to side, as his own now-falsified theories were focused on measurements along that axis as of potential significance. It nevertheless seems strange that Smyth should not have noted that the height was 1 Egyptian cubit, but solid information regarding the real cubit standard and measurement techniques used by the Ancient Egyptians was not readily available during his lifetime, and the issue of measurement standards remained confused in several important respects.

Analysis of the thickness/height of the casing stone

Heavy though this casing stone is, it is small compared to the giant sloped stones still in place along the northern side of the base of the Great Pyramid. Most of the fine Tura casing stones were stripped off the Great Pyramid and recycled to build Cairo during the medieval period, but a few of the huge base row remain in place, where they were protected under mounds of fragmented stone that gathered along the edges of the pyramid over the centuries. Given the discrepancy in size between the surviving Giza base stones and the smaller stone in Edinburgh, the first question I addressed was whether or not this smaller stone was actually from the Great Pyramid at all, or if it came from one of the similarly proportioned queens pyramids nearby. They were constructed at the same time as the Great Pyramid (or shortly after) around 2,550 B.C., and to the same slope angle,[14] but were built using casing blocks of around this smaller size.

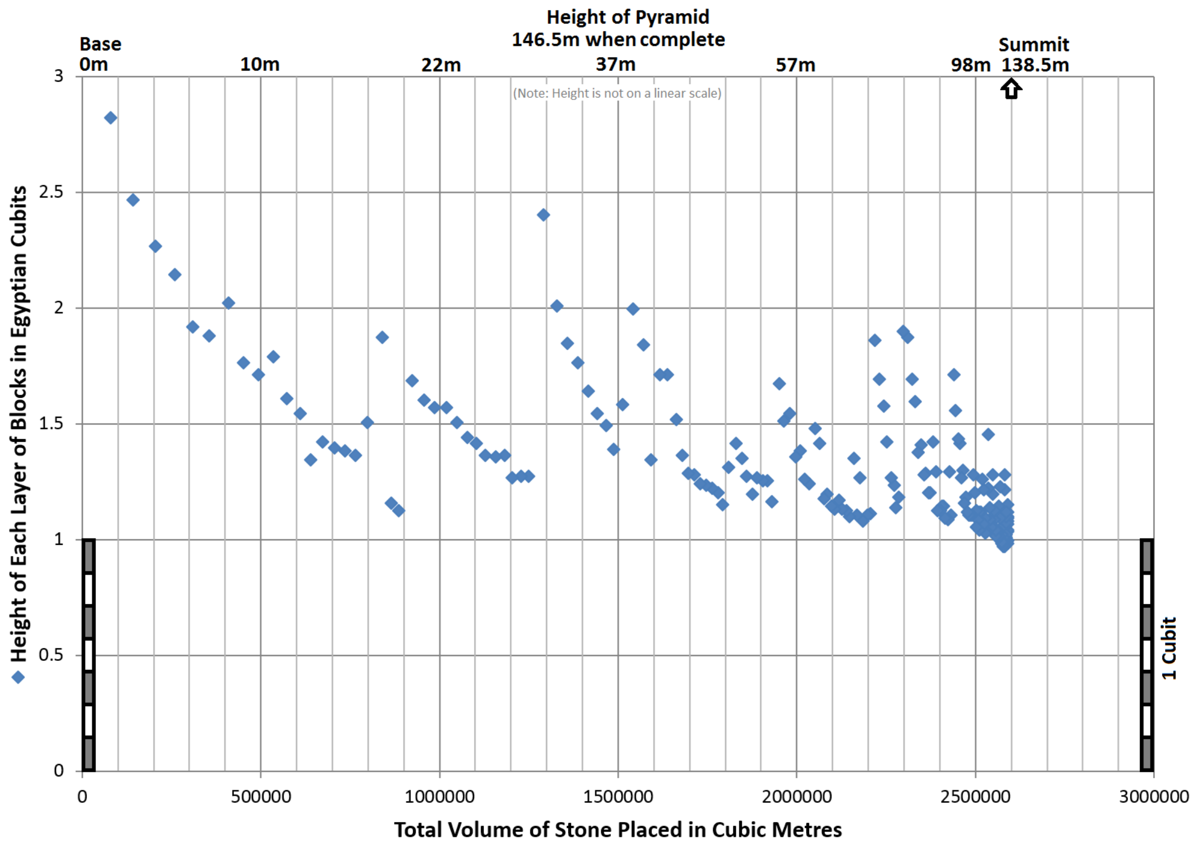


Fig. 4. Height of each of the 175 layers of the Great Pyramid measured, from bottom, left, to top, right.

14 Maragioglio and Rinaldi (1965), p. 80.

Surviving casing stones still in place on the upper levels of pharaoh Khafre's pyramid, however, demonstrate that smaller casing stones were also used near the peaks of the larger structures. As Lehner described with respect to the second Giza pyramid of Khafre,[15] 'the casing stones at the top of the pyramid are much smaller – about 1 cubit thick (c. 50 cm/20 in)'.

It was not just the casing stones that were smaller towards the summits of the pyramids. During his 1883 survey Flinders Petrie measured the height of every individual layer of the core blocks of the Great Pyramid, at the north-eastern, and south-western corners,[16] from the base to the current summit. His data clearly show that as the summit is approached the height of the core layers tend closer and closer to 1 cubit in thickness.

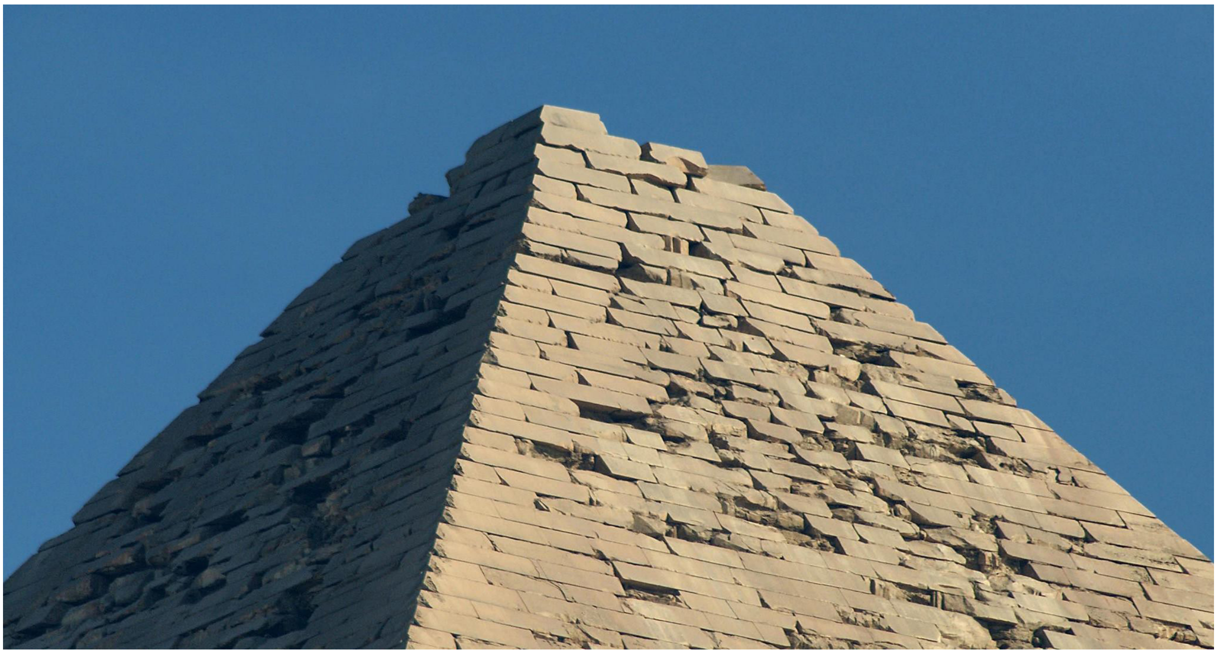


Fig. 5. Casing stones still *in situ* near the summit of the Pyramid of Khafre at Giza, showing a high degree of regularity which may have contributed to their structural integrity and survival. With permission © Franck Monnier.

The graph (Fig. 4) provides Petrie's data in a format whereby the total volume of blocks set in place is plotted against the height or thickness of each layer, as the pyramid was built, from the ground level (left) to the summit (right). The layer heights clearly trended in cycles. This is most likely because the core blocks naturally varied in height due to the varying heights of the stratified layers of rock in the quarries. The stones could be excavated out in layers more easily if the natural stratigraphy was followed. They were then gathered and grouped on-site by size and sorted into a sequence each year, ready for the transportation workforce to become available. Although still unverified, it is though that the transportation teams worked on a seasonal basis and only became available once the agricultural work in the fields by the Nile was completed. When the transportation workforce arrived during the inundation, when agricultural work was impossible, the larger blocks would be sent up to the pyramid first, working down to smaller blocks as the teams tired towards the end of each construction season. The cycles apparent in the stone height dimensions on the graph there-

15 Lehner (1997), p. 122, 123.
16 Petrie (1883), pl. 8.

fore correspond to a period of one year, so that it would have taken around ten or eleven years to set the core block layers in place. The height of the fine Tura casing blocks would not necessarily have matched the roughly cut core blocks (which were quarried closer to the site) in size, but as the summit was approached it appears that more control and consistency was required over the form of each layer, perhaps because the elevation of the blocks became increasingly hazardous (Fig. 5). The reducing magnitude of the pyramidal form would also have been more sensitive to dimensional variations. As a result, smaller core and casing blocks were cut to size as the summit was completed, tending closer and closer to a precise 1-cubit thickness.

But why did sizing of stones so clearly stop at a 1-cubit minimum? One explanation derived from our experiment is that if pairs of cubits were used to measure out and then check slopes of casing stones using the seked system described above, then the blocks must be at least 1 cubit in height. Measurement from the top of the vertical cubit, at right angles horizontally towards the face, cannot be carried out if the stone is less than 1 cubit in height, because the horizontal cubit will not meet the top or front face of the stone.

Hypothetically, the quarry workers would typically have used pairs of cubits in large numbers for rapid every-day measurement of dimensions and angles, to cut the stones to the approximate size for transport, with occasional plumb bob checks. More accurate plumb-levelled angle measurement using cubits may have been reserved for the finishing of the casing stone faces after installation on the pyramid, using the methods shown in the diagrams and animations associated with this article. Triangular templates pre-cut to the correct angle may also have been used.[17] These templates may have been 1 cubit in height if they were made using cubits, but in fact no such triangular tool has ever been recovered. The ease of manufacturing fairly accurate cubit measuring rules, by simply copying an existing cubit of known dimensions, is an important factor to consider when dealing with an industrial-scale quarry site which was producing enormous numbers of stones. Plumb bob tools that could be used in combination with cubits have been found, but it is perhaps unlikely that these were widely used in the quarry. It is likely that the cubit was the primary measurement tool for both linear and angular measurement used throughout the quarry, with more accurate finishing completed at Giza.

The stone in Edinburgh then is most likely a rare survivor; an upper level casing stone from the top of the north face of Khufu's pyramid, perhaps dropped, lost or forgotten during removal in Antiquity or the medieval period. This stone, however, is not 'approximately' 1 cubit tall, it seems to be precisely 1 cubit tall. This level of precision would fit well with the exceptional standards of quality evidenced by the rest of the architectural and archaeological remains of the Great Pyramid, internally as well as externally. It is possible that several layers of the uppermost levels of casing stones of the Great Pyramid of Khufu were constructed to be precisely 1 cubit tall, to make finishing the peak of the pyramid a more controllable process and to ensure that high levels of precision could be maintained over the final form of the structure (Fig. 6). Despite some uncertainty over the exact metrical and construction methods used, it is possibly to say that the Edinburgh casing stone was originally placed near the summit of the monument.

As the stone's outer dimensions are known, its original weight when placed there can also be calculated. Its volume when complete was first calculated and then multiplied by the known density of Tura limestone. This gives a result of 650 kg. This is significantly less than the 2.5 tons usually estimated for regular core blocks, but it remains a very substantial weight. We can only imagine the challenges involved when maneuvering the stone towards the outer edges of the upper levels of Khufu's Great Pyramid, at a height approaching 146 meters over the desert below.

17 Lehner (1997), p. 220.

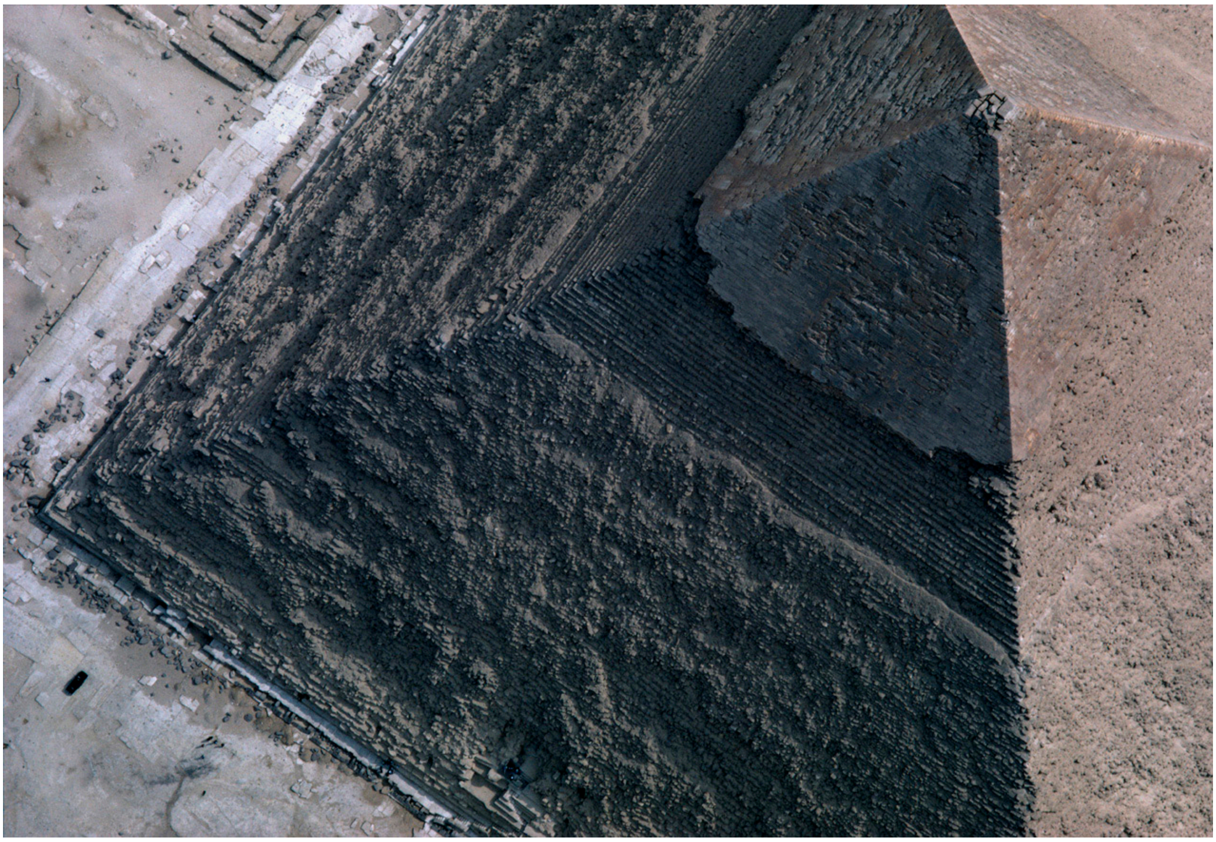


Fig. 6. Aerial view of the casing stones and upper levels of the Pyramid of Khafre. With permission © Kazuyoshi Nomach. The upper layers of this pyramid indicate that a more sophisticated construction method may have been used as the height increased and the summit was approached. A fairly clear horizontal line separates two possible zones of construction.

Analysis of the angle of the casing stone

The image (Fig. 2) and the diagram (Fig. 3) above reconstruct the seked triangle used by the Ancient Egyptians to control the slope of the face. Our experiment demonstrated that the block is exactly one cubit in height and the face offsets by 5 1/2 palms at the top, and so it corresponds exactly with the 'pyramid angle' of the Great Pyramid, and it embodies the very definition of a seked[18] of 5 ½ .

Knowledge of the seked system only came after Smyth's time, thanks to a discovery made by the Scottish antiquarian, Alexander Henry Rhind.[19] In 1864 Rhind was offered a unique papyrus recovered from the West Bank of Thebes that contained some of the oldest mathematical calculations known in human history. Rhind unfortunately died as he brought the mathematical papyrus back to Europe, but it did complete the journey and is now known as the Rhind mathematical papyrus (RMP). It took several decades to understand, translate and publish the content and so Smyth was never familiar with it. It contained many examples demonstrating how to approach typical arithmetic and geometric problems, including how to calculate the required and measured slope face of a pyramid. Using straightforward procedures, the Rhind papyrus showed how the side slope of a

18 Gillings (1982), p. 212.
19 Gilmour (2015).

pyramid's faces can be defined numerically.[20] The technique is comparable to modern day degrees and angles, or inclines quoted in percents that are used on road signs for steep hills. According to the Rhind Mathematical Papyrus, a seked slope consists of the number of palms moved horizontally for each 1-cubit rise.

The examples indicate that the Ancient Egyptian method normally began with the architects choosing the desired base and height dimensions for the pyramid, measured in Egyptian standard cubits. They then worked out what the associated slope value or seked was. It was not usually the seked that determined the base and height dimensions,[21] and so we must look to other reasons for why the choices of overall outer dimensions and proportions were made.

Symbolic meaning of the slope proportions

Smyth, Petrie, and Agnew and Taylor before them, and many modern day Egyptologists, including the National Museum of Scotland's previous curators, have noted that this angle, a seked of 5 1/2, not only corresponds with the slope of the Great Pyramid's faces, but is the precise slope required to give the building proportions that match significant proportions of a circle.[22] The observed geometric relationship is as follows: a circle formed by using the height of the pyramid as a radius, precisely equals the length of the pyramid's perimeter at ground level. This relationship only holds for a pyramid of this precise slope. The basic data that can be used to test this relationship for the Great Pyramid was first accurately derived from Petrie's survey and is as follows: The original form of the completed building was 1760 cubits around and it was 280 cubits in height. Petrie discussed the proportions at length in 1883 and in several later publications.[23] Later surveys have confirmed the accuracy of Petrie's 1883 survey results, with only small adjustments,[24] and data derived from surviving base layer casing stones also agree with the conclusions reached by Petrie and others who followed.

Display cards saved by National Museums Scotland (Fig. 7) show what the curators thought of the stone over the years since it arrived in Edinburgh, including their evolving estimates for the date of construction of the Great Pyramid (2,170 B.C. and 2,200 B.C. compared to today's estimate of 2,550 B.C. to 2,600 B.C.). The curators were clearly aware of the circle-related proportions represented by the slope of the block's face, and that Smyth had investigated this issue, something they refer to as a characteristic of a 'theoretical *pi*' pyramid. This phrase is, however, a rather unfortunate term, derived from Smyth's own discussions, as the abstract ratio *pi* is not something that is applicable within the Ancient Egyptians' practical construction and measurement context, or within their mathematical systems. As will be discussed, it is most likely that they used a multiplication factor of 3 1/7th rather than an abstract ratio.

---

20 Chace (1929).

21 Of the six examples involving sekeds on P. Rhind, 56, 57, 58, 59a, 59b, 60, four show the seked calculated from the base and height, 56, 58, 59a, 60. The other two problems calculate the height from the seked and base dimension, but these two, 57, 59b, are in fact reverse calculations of problems 58 and 59a. This implies that the normal procedure was to calculate the seked from the chosen base and height dimensions. It is also likely that whole number seked results were preferred, to facilitate measurement and construction. Some interplay between the different factors would be expected during the design phase to find an optimum solution, and artistic/ritual symbolism would have been one of those factors. It is clear, however, that the scribes were able to calculate fractional sekeds if required, at least during the Middle Kingdom.

22 Verner (1997), p. 70; Mojsov (2005), p. 26; Edwards (1979), p. 269.

23 Petrie (1883); Petrie (1892); Petrie (1925); Petrie (1940), p. 30; Petrie (1990). Note that the latter publication is a 1990 reprint of his 1885 revised version of his 1883 survey report. The 1885 version in fact contained the most extended discussion of this issue.

24 Cole (1925); Dash (2016). The length of each side was 440 cubits.

Substantive arguments have been made, based on textual evidence in mathematical papyri, that the Ancient Egyptians were not able to calculate circumferences of circles to the required degree of accuracy to account for the accuracy of the relationship,[25] however, the latest analyses show that if the archaeological evidence is revisited and more appropriately examined, then the textual evidence and the architectural evidence can be shown to be complimentary rather than contradictory. The evidence available can support the conclusion that the Old Kingdom Egyptians were able to calculate symbolic geometric values of the required type to construct heights and perimeters, and by extension seked slopes and proportions, to the observed degrees of accuracy.[26]

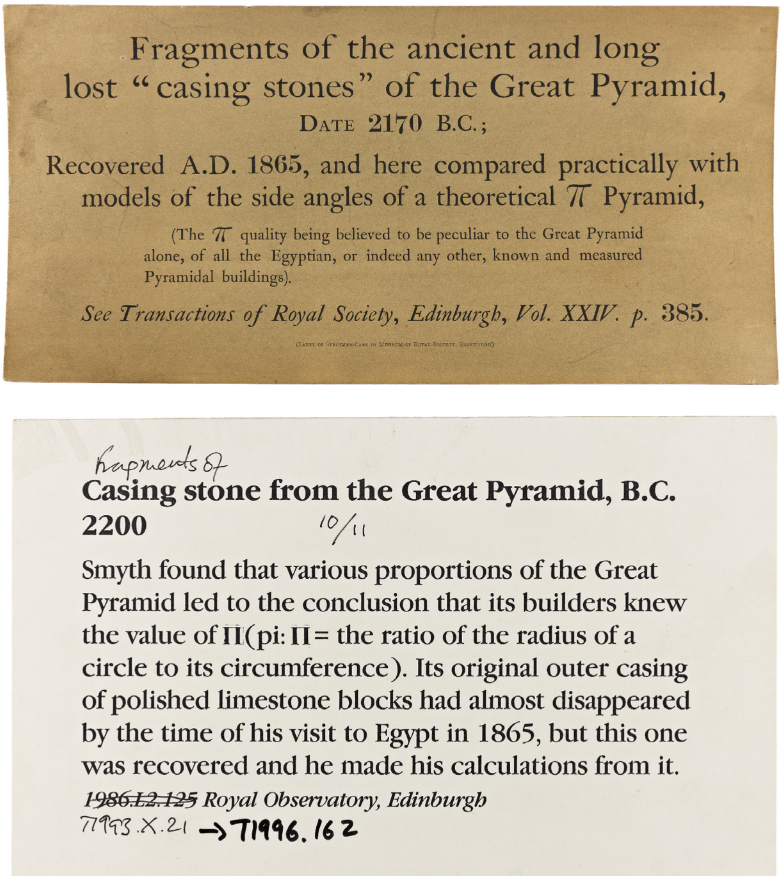


Fig. 7. Surviving annotated redundant display cards from the stone's time in Edinburgh. With permission, NMS.

The protective symbolism of encircling forms

After studying this issue in some depth for over a decade, I have tried to understand what the inclusion of circular proportions in the principal dimensions of rectilinear buildings would have meant to the Ancient Egyptians themselves. I argue that this architectural phenomenon fits well within a wider cultural context that was of distinct ritual significance during the Old Kingdom, and which built on the Predynastic and Early Dynastic cults of Hierakonpolis. My research results

25 Rossi (2006), p. 67. Also see the addendum after the conclusion of the present article for an extended excursus regarding the evidence from mathematical papyri.

26 Cooper (2013).

indicate that the special proportions manifest a deep-seated belief in the active power of encircling protective and purifying symbolism,[27] perhaps to the extent that the Ancient Egyptian architects felt that it bestowed actual structural strength and integrity on the monuments they designed. The application of circular proportions around the granite 'king's chamber' and around the perimeter of the pyramid of Khufu suggest that the architects intended to encircle and protect these enclosed spaces. Iconographically this symbolism seems to have been represented by the shen rings, often carried by the royal avian guardians Horus and Nekhbet. In later periods, entrances to sacred temple enclosures (temenos areas surrounded by peribolos walls), were often overlooked by the avian figures of Horus or Nekhbet, with wings spread and carrying the shen rings. Lintels spanning the doorways into these temenos areas often had the royal raptors carved onto their undersides. The 'shen rings' carried by the pharaoh's own patron god represented the encircling royal protection of the falcon Horus and his built structures. Horus protected the pharaoh and his buildings and Egypt was his protectorate.

The pharaoh was linked to the heavens through this avian symbolism, where he was associated with both the shen ring and the solar disk. The pharaonic theme of the gyring, vigilant, falcon above ultimately drew its inspiration from the natural world, but was used as a metaphor for protecting the institutions of pharaonic rule. Through these special motifs in the architecture of his monuments, Khufu separated himself and planned to move above his compatriots. It was a restricted form of propaganda that elevated the pharaoh above even his closest advisors, such as Hemiunu and prince Ankhhaf who helped design and build his monument.[28] The encircling symbolism expressed in the architecture was also expressed graphically on portable material culture belonging to the cults of the Ancient Egyptian pharaohs of the Old Kingdom, such as on crowns, royal statues and fine furniture.[29] Recently I showed how the apotropaic symbolism was represented on a series of high status vases decorated with avian themes including Horus carrying the shen rings. These vases were used within the pyramid complexes of the pharaohs.[30] I argued that during the Old Kingdom, although these symbols were ubiquitous within royal cult mortuary contexts, they were used discretely.

The Egyptians performed ritual circumambulations (*dbn*, *pẖr*) of monuments for many important occasions. Ritner described the centrality of the circumambulation rite within the Old Kingdom pharaonic culture as 'striking'.[31] The encircling symbolism is most clearly attested textually with respect to pyramid architecture in Pyramid Text 534.[32] This is a spell or prayer of encirclement, protection and purification for the pyramid and its temple, written on the walls of the entrance passage into the pyramid of Pepi I at south Saqqara. In this text the phrase PT 534 §1277c includes the term 'the pyramid and temple are encircled'  'for Pepi and for his Ka'. The first two

27 Wilkinson (1987); Ritner (2008).

28 Vizier Ankhhaf, half-brother of Khufu, is also mentioned in the Al-Jarf papyri and may have been involved in the construction of the Great Pyramid. His period of activity is situated chronologically at the end of the reign of Khufu. A fine bust of Ankhhaf is now in the Boston MFA, 27.442. He was buried in tomb G 7510 at Giza. Similarly, a fine statue of Hemiunu, thought to have been the architect of the Great Pyramid and a grandson of pharaoh Sneferu, is now in the collection of the Pelizaeus Museum in Hildesheim, Germany, PM 1962. It was found in his tomb at Giza, G4000 in 1912. This large mastaba is located at 29°58'45»N, 31°7'47»E.

29 Lightbody (2012).

30 Lightbody (2016).

31 Ritner (2008), p. 68. See also papers by Anthes (1961) and Brovarski (2009).

32 Faulkner (2007), p. 201, 202; Osing (1994).
ḥtp di͗ Gb ʾItm
wdn mr ḥwt-nṯr pn n (Ppi͗)| n kꜣ.f
šnnt mr ḥwt-nṯr pn n (Ppi͗)| n kꜣ.f
wꜥb i͗rt Ḥr tw.

glyphs, V7 and N35, form the syllables of the word for encircled, shen, *šnw*. These are the same signs used to write the name of the shen ring; a word also used for the cartouche which encircled and protected the pharaoh's name.

As the Old Kingdom proceeded, the primary vehicles for expressing pharaonic funerary symbolism evolved towards pyramid texts, statuary and iconography rather than monumental architectural proportions. Political power started to decentralize away from the pharaoh.[33] These changes help to explain why the later pyramids and solar temples employed various different dimensions and proportions, more appropriate to their own unique historical contexts. There was no one-rule-fits-all, but the same underlying ideas and symbols were subsequently recycled time and again, in an increasingly retrospective legitimation process.

Discussion of Smyth's analysis

Smyth (1819-1900) originally came into contact with the issue after reading a book by English author and publisher John Taylor, published in 1859. One of the first authors to write extensively on this matter,[34] Taylor had printed H.C. Agnew's original thesis discussing the circular proportions of the pyramids of Giza twenty years previously.[35] Taylor's own lengthy thesis was entitled 'the great pyramid, who built it and why was it built?'. Smyth was circumspect about Taylor's thesis when he first read it,[36] but later went to Egypt to carry out his own survey of the Great Pyramid. On his return he published his own analysis of the Giza monuments[37] and followed this up with several further discussions.[38] He acknowledged that he was influenced and subsequently convinced by Taylor's theories. Smyth and Taylor were both justified in their awe of the architecture of the Great Pyramid, but the conclusions that they drew from the monument's ancient symbolisms were unfounded and irrational. Although Smyth's interpretations were mostly incorrect, his theories were widely influential and caused considerable confusion in the United Kingdom and in the United States.

It seems that in order to find an explanation for an architectural phenomenon, deeply rooted in an Ancient Egyptian culture which they did not understand, they drew on their own religious and nationalist sentiments, and mixed these with their knowledge of biblical history and current scientific trends. Smyth drew conclusions from the resulting mélange 'with most wretched logic'[39] and decided that the almost perfect proportions were clearly divinely inspired, and that the pyramid was a metrological monument built with a 'sacred pyramid inch'.

Flinders Petrie finally resolved the matter with his 1883 report of his high-precision survey of Giza. In that report he rejected all of Smyth's theories, and only accepted the existence of the circular proportions, which he concluded had been deliberately included in the building's original designs.

Conclusion

The dimensions and proportions of the Great Pyramid and its building blocks are of significant historical interest, both with respect to the Ancient Egyptian culture and to the history of science

33 Bárta (2016).
34 Taylor (1859).
35 Agnew (1838).
36 Smyth (1864).
37 Smyth (1867).
38 Smyth (1880); Smyth (1884).
39 Brück and Brück (1988).

during the 19th and 20th centuries. Those dimensions have been surveyed and studied several times in the modern era, at increasing levels of accuracy as modern technology develops. The building's proportions have been addressed by many prominent Egyptologists, and it was the issue of circular proportions that initially attracted one the greatest of all Egyptologist, Flinders Petrie, to study the architecture of the whole Giza plateau complex in such great detail. The casing block in the National Museum of Scotland's collection is part of that story, and its particular form exhibits the crucial dimensions and proportions of outstanding historical significance.

This new research revealed that the Edinburgh stone is the only known example of a casing stone from the upper levels of the north side of the Great Pyramid of Khufu at Giza; one of the most celebrated buildings ever constructed in human history, and the last remaining wonder of the ancient world. The building's characteristics continue to exercise the finest minds and the finest scientific instruments in Egyptology today, and it continues to provoke discussion and yield new information regarding Old Kingdom Egyptian symbolism and ritual.

The stone's purpose was to protect the outer face of the Great Pyramid. I have argued that its circle-related proportions were apotropaic in nature, and were integral to the systems of iconography and ritual that supported the pharaonic funerary cults and the structures of pharaonic rule.

The Giza casing stone left Egypt almost 150 years ago. It is now also a part of Edinburgh's historic fabric, in the collection of the National Museums Scotland, and serves as a memorial to the interesting life and work of the late Astronomer Royal for Scotland, Charles Piazzi Smyth.

Addendum

The handful of surviving calculations involving circles on Ancient Egyptian mathematical papyri appear to show methods using a diameter to calculate circular areas, rather than the radius. This is a different procedure to one employing a radius to produce a circumference, as manifested in the Great Pyramid's proportions. The relevant mathematical papyrus examples are P. Rhind 41, 42, 43, 48, 50.[40]

These texts could be construed as evidence contrary to the conclusions based on the architectural evidence, but it is important to understand, as I set out in 2008,[41] that these examples are calculations of areas, not circumferences. The problems also use the widths of circles rather than diameters, which must by definition pass through the center of a circle. Gillings[42] showed that these calculations on the papyri effectively estimate the area of a square with a width 8/9th of the circular area to be calculated. This does produce an area that is approximately equal to the area of the circle of the specified width, which completes the calculation, but there is no use of a circumference in these calculations, no use of a *pi* like ratio, or even a diameter, strictly speaking. Above all, there is nothing in these problems to suggest that the Egyptians were aware that circular area and circumference calculations can be related using one common factor, as we do today using *pi*.

This evidence relating to circular areas on the papyri, therefore, does not preclude the existence of a different calculation method that used radii to calculate circumferences.[43] Architectural evidence from the monuments, some of which is outlined below, indicates that such a circumference

40 See Gillings (1982) for an analysis of the P. Rhind examples relating to circles, and see Chace (1929) for detailed images and transcriptions of the examples. For the possibly related but very unclear P. Moscow 10 example see Cooper (2010) and Miatello (2013).

41 Lightbody (2008), p. 54.

42 Gillings (1982), pp. 143-144.

43 Lightbody (2008), p. 47.

calculation method was based on using the number 7 for the radius or width of a circle, so that its circumference would then be 44 parts, or 22, depending on which was used. These basic numbers work very readily with the Ancient Egyptians' 7-part cubit system,[44] and could have been scaled to whatever architectural dimension was required.

There is no evidence that circumference-related numbers were adapted for use in circular area calculations at that time. The area calculation method described on the papyri may have been used predominantly for agricultural and alimentary quantification purposes rather than for construction processes associated with the lengths and perimeters of structures.[45]

Furthermore, in my analysis of 2008[46] I suggested that the earliest known example of circular proportions in monumental pharaonic architecture, at Saqqara, also used a circular width based relationship: the Saqqara Step Pyramid enclosure wall has an internal north-south dimension of 1000 cubits, while its perimeter is 3,142 cubits around.[47] Other values have been quoted for this distance, but none vary more than 0.2 % from this value which is very close to the circumference of a circle of diameter 1000 cubits.

There are also fine embedded circular columns decorating the entrance to the 'T temple' at Saqqara that would have had 22 channels running down their faces at equal intervals if completed in the round. It required a fairly sophisticated geometric understanding of circumferences to manufacture them accurately, and so the subdivision into 22 parts in this context is notable.[48]

An early understanding of a relationship between widths and circumferences of circles at Saqqara then implies that what we see at Giza, where the radius is used, is a slightly later development of the simpler geometric and symbolic relationship first developed for the Step Pyramid enclosure. If this scenario is correct then the basic width/circumference method must have been adapted towards the end of the 3rd Dynasty and early 4th Dynasty to produce a method allowing radius based circular calculations and constructions. Radii based numbers would have been more practical for use when constructing circles accurately using cords attached to a central point. The proportions would also have been more readily adaptable to the basic pyramid form, which was already evolving into a shape close that which allowed incorporation of the radius/height : circumference/perimeter relationship which we see today in Khufu's structure.

The basic proposal here is that there were simple architectural methods, first involving circular widths and then radii, used for calculating circumferences, that do not appear on the papyri, and which were unrelated to the Ancient Egyptian calculation methods for circular areas (or indeed spherical volumes[49]). This means that the papyri examples in fact provide evidence complimentary to the architectural evidence, rather than contradictory. This is effectively what Cooper also proposed in 2011.[50]

Finally, additional supporting evidence can be derived from the Ancient Egyptians' unit fraction system.[51] Using the unit fraction system along with the 7-part cubit for a circular width, it is easy to

44 Other researchers have noted the repeated occurrences of the numbers 7, 11, 22, 44 in other aspects of the architecture of the early Old Kingdom pyramids. See the interesting article by Miatello (2008) who also related these numbers to circles and the solar circle in particular.
45 See Zapassky *et al.* (2012).
46 Lightbody (2008), p. 47.
47 Verner (1997), p. 461.
48 Cooper (2010), p. 470.
49 Zapassky *et al.* (2012).
50 Cooper (2011).
51 Lightbody (2008), p. 47.

find that a circumference is very precisely 3 and 1/7th cubits, simply by spinning the cubit around at its halfway point and measuring the described perimeter with a string. This is written in hieroglyphs as follows: . If this basic circular width/circumference multiplier was adapted for use in radius/circumference calculations, then the whole number 3 and fractional number 1/7th would have been doubled to obtain the factor for calculating a circumference from a radius. This gives 6 + 1/4 + 1/28th in the Ancient Egyptian unit fraction system, and is written as follows in hieroglyphs: . At first sight this seems like a clumsy fraction to use in calculations, but it fits the Egyptian cubit measurement system very well. The 7-part cubit was further subdivided into 28 digits and so a 1-cubit radius circle is also 28 digits in radius. The circumference produced by this 28-digit cubit would then multiply out to be 176 digits in length (28x6 + 28/4 + 28/28 = 176). These numbers are clearly similar to the actual dimensions used for the Great Pyramid, which was 280 cubits high by 1760 cubits around when complete, lending credence to this reconstruction. Petrie also noted that these same proportions and numbers were used in the so called 'king's chamber' of the Great Pyramid, where the width is 280 digits while the perimeters of the north and south walls are 1760 digits, suggesting an effort to incorporate numbers related to the circle, and hence the encircling shen/cartouche symbolism, into and around that most protected of spaces.

Bibliography

Anthes, R. (1961), 'Das Verbum Sni "umschließen, bannen" in den Pyramidentexten', *ZÄS* 86, pp. 86-89.
Agnew, H. C. (1838), *A Letter From Alexandria on the Evidence of the Practical Application of the Quadrature of the Circle in the Configuration of the Great Pyramids of Giza*, London: Longman, Orme, Brown, Green and Longmans.
Arnold, D. (1991), *Building in Egypt. Pharaonic Stone Masonry*, Oxford: Oxford University Press.
Bárta, M. (2016), '"Abusir Paradigm " and the Beginning of the Fifth Dynasty', in I. Hein, B. Nils and E. Meyer-Dietrich (eds.), *The Pyramids. Between Life and Death. Proceedings of a Workshop held at Uppsala University 2012*, Uppsala: Uppsala Universitet, pp. 51-74.
Brovarski, E. (2009), 'Once More Hr, "Pyramid "?', in D. Magee, J. Bourriau and S. Quirke (eds.), *Sitting Beside Lepsius: Studies in Honour of Jaromir Málek at the Griffith Institute,* Leuven: Peters, pp. 99-114.
Brück, H.A. and Brück, M. (1988), *The Peripatetic Astronomer: The Life of Charles Piazzi Smyth*, Bristol: Hilger.
Chace, A. B. (1929), *The Rhind Mathematical Papyrus*, Ohio: Oberlin.
Cole, J. H. (1925), *The Determination of the Exact Size and Orientation of the Great Pyramid of Giza*, Cairo: Survey of Egypt.
Cooper, L. (2010), 'A New Interpretation of Problem 10 of the Moscow Mathematical Papyrus', *Historia Mathematica* 37, pp. 11-27.
Cooper, L. (2011), 'Did Egyptian Scribes Have an Algorithmic Means for Determining the Circumference of a Circle?', *Historia Mathematica* 38, pp. 455-484.
Dash, G. (2016), 'The Great Pyramid's Footprint: Results from Our 2015 Survey', *AERAGRAM* 16(2), pp. 8-14.
Edwards, I.E.S. (1979), *The Pyramids of Egypt*, Penguin.
Faulkner, R.O. (2007), *The Ancient Egyptian Pyramid Texts,* Kansas, pp. 201-202.
Gillings, R. (1972), *Mathematics in the Time of the Pharaohs*, New York: Dover.
Gilmour, C. (2015), 'Alexander Henry Rhind (1833-63): A Scottish Antiquary in Egypt', *Proceedings of the Society of Antiquaries of Scotland* 145, pp. 1-14.
Lauer, J.-Ph. (1931), 'Étude sur quelques monuments de la III[e] dynastie (pyramide à degrés de Saqqarah)', *ASAE* 31, p. 60.
Lehner, M. (1997), *The Complete Pyramids*, London: Thames & Hudson Ltd.
Lepsius, K. R. (2000), *The Ancient Cubit and its Subdivisions Expanded and Edited by Michael St. John*, London: Museum Bookshop Publications.
Lightbody, D. I. (2008), *Egyptian Tomb Architecture: The Archaeological Facts of Pharaonic Circular Symbolism*, Oxford: British Archaeological Reports International Series and Archaeopress.
Lightbody, D. I. (2012), 'The Encircling Protection of Horus', in H. Abd El Gawad , N. Andrews, M. Correas Amador, V. Tamorri and J. Taylor (eds.), *Proceedings of the Twelfth Annual Symposium Current Researches in Egyptology, 2011, University of Durham Oxford*, Oxbow, pp. 133-140.
Lightbody, D. I. (2016), 'The Encircling Motifs of Old Kingdom Avian Themed Pharaonic Vases', *GM* 249, pp. 111-123.
Maragioglio, V. and Rinaldi, C. A. (1965), *L'architettura delle piramidi Menfite 4. La Grande Piramide di Cheope, Text*, Rapallo: Tipografia Canessa.
Miatello, L. (2008), 'A Solar Rule in the Architecture of Fourth Dynasty Pyramids', *Ankh* 17, pp. 41-57.
Miatello, L. (2013), 'Problem 10 of the Moscow Mathematical Papyrus: Corrupted Part or Technicality?', *GM* 237, pp. 55-70.
Mojsov, B. (2005), *Osiris. Death and Afterlife of a God*, London: Blackwell Publishing.
Osing, J. (1994), 'ZuSpruch 534 der Pyramidentexte', in C. Berger, G. Clerc and N. Grimal (eds.), *Hommages à Jean Leclant,* 1, IFAO: Cairo*,* pp. 279-284.
Petrie, W. M. F. (1883), *The Pyramids and Temples of Gizeh*, London: Field and Tuer.
Petrie, W. M. F. (1892), *Medum,* London: David Nutt.
Petrie, W. M. F. (1925), 'Surveys of the Great Pyramids', *Nature*, pp. 942-943.
Petrie, W. M. F. (1940), *Wisdom of the Egyptians*, London: British School of Archaeology in Egypt and Egyptian Research Account.
Petrie, W. M. F. (1990), *The Pyramids and Temples of Gizeh - 2nd Edition from 1885 Republished in a New and Revised Edition with an Update by Zahi Hawass*, London: Histories and Mysteries of Man Ltd.

Ramsay, C. B., Dee, M. W., Rowland, J. M., Higham, T. F. G., Harris, S. A., Brock, F., Quiles, A., Wild, E. M., Marcus, E. S. and Shortland, A. J. (2010), 'Radiocarbon based dating for early Egypt', *Science* 328, Issue 5985, pp. 1554-1557.

Ritner, R. K. (2008), *The Mechanics of Ancient Egyptian Magic*, Chicago: The Oriental Institute of the University of Chicago.

Rossi, C. (2003), *Architecture and Mathematics in Ancient Egypt*, Cambridge: University Press.

Smyth, C. P. (1864), 'On the Reputed Metrological System of the Great Pyramid', *Proceedings of the Royal Society of Edinburgh* XXIII, pp. 667-706.

Smyth, C. P. (1867), *Life and Work at the Great Pyramid During the Months of January, February, March, and April, A.D. 1865*, 3 Volumes, Edinburgh: Edmonston and Douglas.

Smyth, C. P. (1874), *Our Inheritance in the Great Pyramid*, London: W. Isbister & Co.

Smyth, C. P. (1880), *Our Inheritance in the Great Pyramid*, 4th Edition, London: W. Isbister & Co.

Smyth, C. P. (1884), *New Measures of the Great Pyramid*, London: R. Banks.

Tallet, P. (2016), 'Un aperçu de la région Memphite à la fin du règne de Chéops selon le "journal de Merer" (P. Jarf I-III)', in S. Dhennin and Cl. Somaglino (eds), *Décrire, imaginer, construire l'espace : toponymie égyptienne de l'Antiquité au Moyen-Âge*, Cairo: IFAO, pp. 13-30.

Tallet, P. and Marouard, M. (2014), 'The harbour of Khufu on the Red Sea Coast at Wadi al-Jarf, Egypt', *Near Eastern Archaeology,* 77:1, pp. 4-14.

Taylor, J. (1859), *The Great Pyramid: Why was it Built? And Who Built it?*, London: Longman, Green, Longman, and Roberts.

Verner, M. (1997), *The Pyramids: Their Archaeology and History*, Atlantic Books.

Wilkinson, G. (1841), 'Manners and Customs of the Ancient Egyptians', Chapter XI, vol. I, 2nd series, London: John Murray.

Wilkinson, R. H. (1987), 'The Coronational Circuit of the Walls, the Circuit of the HNW Barque and the Heb-Sed "Race" in Egyptian Kingship Ideology', *JSSEA* 15: 1, pp. 46-51.

Zapassky, E., Gadot, Y., Finkelstein, I. and Benenson, I. (2012), 'An Ancient Relation between Units of Length and Volume Based on a Sphere', *PloS One* 7:3, pp. 1-6.

A look through his window: the sanctuary of the divine Apis Bull at Memphis

Nenad Marković[1]

The creator-king-god Ptah[2] and the living Apis bull which was his visible earthly manifestation enjoyed supreme religious and socio-political importance at Memphis, one of Egypt's oldest political, economic, administrative, and sacral capitals. The large temple enclosure of Ptah once stood as the focal point within the central part of the settlement and dominated the landscape, everyday life, and the elite culture of Memphis for centuries.[3] Social networks and power groups active in Memphis were mostly concentrated around the Ptah precinct. This is particularly well documented between the New Kingdom (c. 1,539-1,077 B.C.) and the end of the Ptolemaic period (30 B.C.), although never fully explored in modern scholarship.[4]

I argue here that the south-western corner of the temple enclosure was the area where successive Apis divine bulls spent their lifetimes in a sanctuary, venerated as a living herald, and later even the ba, of the god Ptah.[5] As a rule there could only be one Apis bull at a time, born around the same time as the death of his predecessor and identified by a set of previously-defined bodily markings. According to a long-standing tradition the main cultic episodes in the life of Apis included birth, coronation/installation, death, and burial.[6] Apis could appear anywhere in Egypt.[7] Once found, the animal was taken, along with its mother, to the House of the Inundation of the Nile (Nilopolis of Diodorus Siculus), a sanctuary most probably located on the east bank of the Nile towards Old

---

1 Czech Institute of Egyptology, Charles University in Prague.

2 This study has been written thanks to the financial support of *Stiftungsfonds für Postgraduates der Ägyptologie* (Austrian Academy of Sciences).

3 Temple is described in Hdt. 2.153; Diod. 1.84,6; Strabo 17.1.31. For the most recent analysis of the material on site, see Leclère (2008), pp. 39-91.

4 For the Ptolemaic era, see Gorre (2009), pp. 216-344, Thompson (2012), and Panov (2015). It is important to note here that such an unfortunate situation for earlier periods in the history of Memphis is going to be gradually changed after publication of the currently on-going project ('Memphis in der Dritten Zwischenzeit' of Dr Claus Jurman, Wien Universität), several completed PhD dissertations ('Studies in the Saqqara New Kingdom Necropolis. From the Mid-19th Century Exploration of the Site to New Insights into the Life and Death of Memphite Officials, Their Tombs and the Use of Sacred Space' of Dr Nico Staring, Macquarie University, Sydney, 2016; 'La statuaire privée memphite de la XXVe dynastie au début de la XXVIIe dynastie' of Dr Melanie Cressent, Université Lille 3, 2013; 'Recherches sur la cour royale égyptienne à l'époque saïte (664-525 av. J.-C.)' of Sepideh Qahéri-Paquette, Université Lumière Lyon 2, 2014; 'Turmoil and Power: A Thematic and Chronological Study of Dynastic Transition in Late Period Egypt' of Dr Jared Krebsbach, University of Memphis, 2013; 'The Archaeology of Achaemenid Rule in Egypt' of Dr Henry Colburn, University of Michigan, 2014), and two future PhD dissertations ('Prosopographia Memphitica. Individuelle Identitäten und kollektive Biographien einer Residenzstadt des Neuen Reiches' of Anne Herzberg-Beiersdorf, Freie Universität Berlin; 'Between Dynastic Changes, Political Power, Prestige, Social Status, and Court Hierarchies: A Prosopographical Study of the Memphite Elite Families in the late Saite and at the beginning of Persian Era (570-486 BCE)' of the present author).

5 Cf. Otto (1938), pp. 25-27.

6 Jurman (2010), pp. 230-235 with earlier literature.

7 For the home towns of the Ptolemaic Apis bulls, see Devauchelle (1994), pp. 83-85; Farid (1997), pp. 51-57.

Cairo,[8] where the newly-found Apis calf and his mother allegedly spent forty days before being transferred across the Nile on the night of the full moon to Memphis for the installation within the temple of Ptah.[9] Upon its natural death, the bull was assimilated with the god-king of the underworld, Osiris, as Apis-Osiris and Osiris-Apis respectively, initially following the Ancient Egyptian tradition that every justified being is identified with Osiris after death, and it later grew to be the unique Memphite form of Osiris himself.[10] Accordingly, when represented as a psychopomp deity, the scenes of the Apis bull carrying the mummy of the deceased on its back appear on the foot ends of cartonnage and coffins under Sheshonq I (c. 943-922 B.C.) and are attested regularly across Egypt up to the Roman era.[11]

Fig. 1. Painted limestone statue of the sacred Apis bull, Louvre N 390 (photo courtesy of Alain Guilleux).

8 For the location of the sanctuary in the area of Athār an-Nabī, see Burton (1972), p. 246; Bresciani (1983); Vos (1993), p. 164.
9 Diod. 1.85,2. For the full moon, see Ael. NA 10.10. Cf. Krauss (2007), pp. 339-348.
10 Cf. Devauchelle (1998), pp. 593-594; Aly (2006), pp. 47-50; Devauchelle (2010), pp. 49-62.
11 Cf. Jurman (2010), pp. 228-230.

During the Early Dynastic period, as well as the Old Kingdom era, the Apis bull was perhaps predominantly used as a processional animal, symbolizing the fertility of crops and fields and agricultural rejuvenation, and associated with the periodic celebrations of royal public festivals at Memphis, like the Sed-festival or the king's coronation.[12] The organized cult of the divine Apis bulls appears in surviving sources only from the mid-second millennium B.C. onwards, perhaps already in the early 18th Dynasty (c. 1539-1390 B.C.), when the aforementioned rituals were apparently incorporated into the temple-based performances. Although the Apis bulls were known from the 1st Dynasty onward,[13] evidence that the bulls were individually buried extends almost continuously from the middle of Amenhotep III's reign (c. 1390-1353 B.C.) until the second half of the second century A.D. and possibly somewhat later. The focus of the elaborate burial ceremonies was a carefully embalmed mummy of a bull, carried in a long funerary procession from the Ptah precinct in Memphis to North Saqqara, where it was placed originally in a coffin, replaced later by a large stone sarcophagus under Amasis (570-526 B.C.). These were placed within the separate underground vault of the Serapeum on every attested occasion until the very end of the Ptolemaic era at latest; although it is plausible that the Serapeum was abandoned as the burial place of the Apis bulls during the early years of the Roman era[14] as the burials of the Roman bulls have not yet been discovered. While the last known Apis burial is from c. 170 A.D., the bull's divine protection was still sought in private prayers in the early third century A.D. and the last bull was reportedly found in 362 A.D. on the personal order of the Emperor Julian the Apostate.[15] The funerary aspect seems to have become the most prominent within the personal religious practice of the mixed Memphite population during the Third Intermediate and Late Periods (c. 943-332 B.C.) and extended even beyond the Nile Valley, especially during Hellenistic and Roman times, when the bull was considered a subordinate aspect of the joint cult of Osiris/Sarapis and his sister-wife Isis all over the Mediterranean world.[16]

The Place of Apis

The Place of Apis (*tꜣ s.t Ḥp*) is a Demotic term used for the building or more likely complex of buildings where the Apis bulls were kept, lived, died, and were prepared for burial. In the hieroglyphic text of the Memphis Decree (the Rosetta stone; 197 B.C.), the Place of Installation of the living Apis (*ḥwt-sẖn n.t Ḥp ꜥnḫ*) is used as a synonym for the Place of Apis.[17] Furthermore, the Place of Apis is mentioned several times in The Apis Embalming Ritual, a detailed manual describing the embalming process of the divine bull. This text is preserved on the late Ptolemaic papyrus P. Wien KHM ÄS 3873, written in Hieratic and Demotic (rt. I-VI; vs. I-III),[18] and its recently-published first column P. Zagreb 597-2, written mainly in Hieratic with many passages in Demotic (rt. 0). The former is a Ptolemaic copy making references to events of 351/350 B.C.[19] The sanctuary is referred to four times on P. Zagreb 597-2 (rt. 0, 11, 12, 17),[20] and only once in P. Wien

12 Kessler (1989), pp. 70-71. Wilkinson (1999), p. 243, argues that Apis was in fact a separate deity during the Early Dynastic times.
13 Simpson (1957), pp. 139-142.
14 Dodson (2005), p. 89.
15 For the most complete list of known Apis bulls during the Pharaonic and Ptolemaic times, see Dodson (2005), pp. 90-91, with additional comments in Meyrat (2014b), pp. 307-309. For the Apis bulls during the Roman era, slightly outdated, but still useful is Hermann (1960). The present author is preparing several studies regarding the Apis bulls under the Roman rule.
16 Cf. Devauchelle (2012), pp. 213-225.
17 See Quirke and Andrews (1988), pp. 13, 15, 19.
18 For the date of the papyrus, see Vos (1993), p. 7.
19 Cf. Meyrat (2014b), p. 315.
20 Meyrat (2014b), pp. 266-267, 268-269.

KHM ÄS 3873 (rt. IV 10),[21] which can aid further identification of the precinct's other parts. Nevertheless, its exact location and layout are yet to be identified on the site since large parts of the Ptah temple enclosure now lie hidden under the modern settlement of Mit Rahina. Despite the lack of hard evidence, the Place of Apis must have been the same as the one mentioned by Strabo: 'the bull Apis is kept in a kind of sanctuary, being regarded, as I have said, as god'.[22] Unfortunately, no living quarters for most of the numerous attested sacred animals across Egypt (for example, a ram

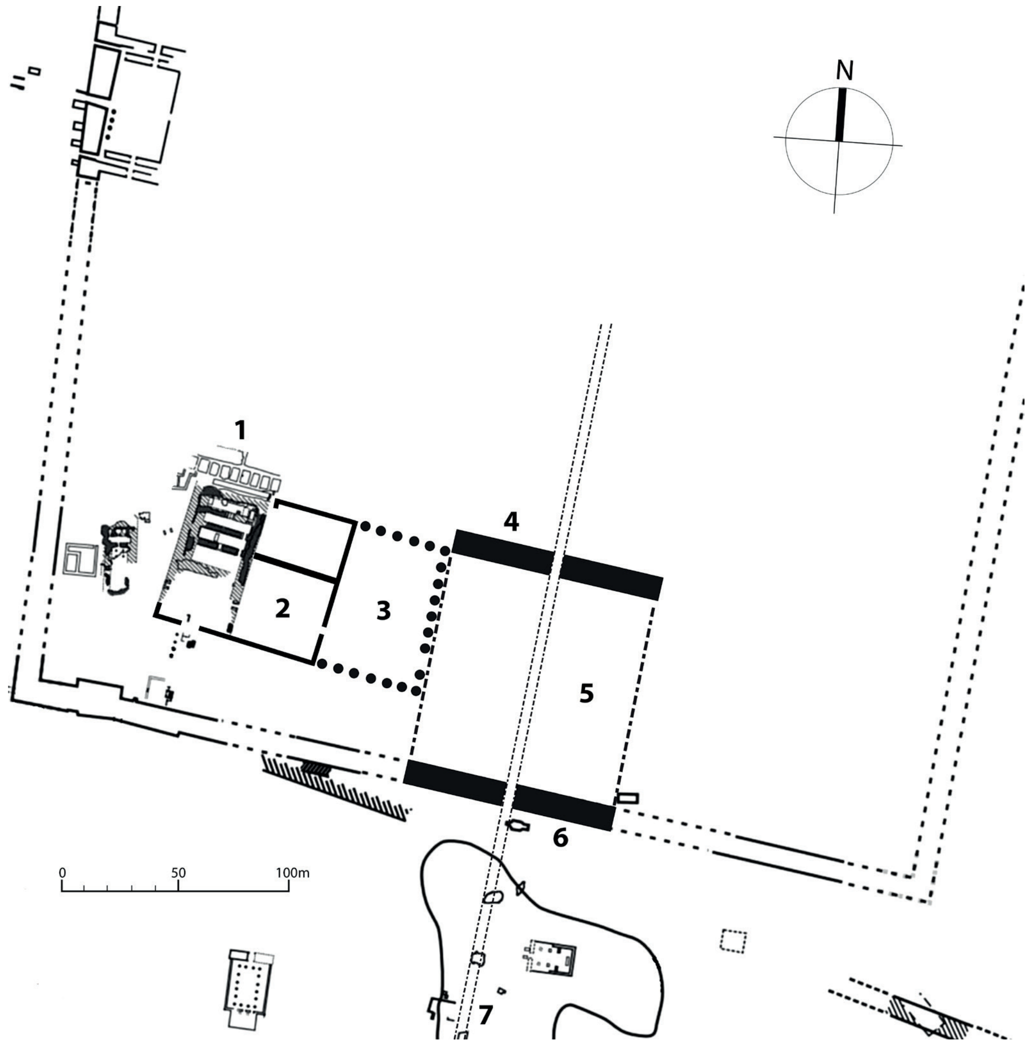


Fig. 2. Presumed map of the southwestern part of the precinct of Ptah, compiled from maps in Jeffreys (1985), Jones and Milward Jones (1988), p. 106, fig. 1 and Jurman (2010), p. 240, fig. 3:1. The Place of Embalmment; 2. The stall; 3. The Pavilion of Appearances; 4. The gateway of Psammetichus I; 5. The southern courtyard; 6. The southern entrance gateway, the Colossus of Ramses II and the open-air museum; 7. The Sacred Way.

21 Vos (1993), pp. 51, 249.
22 Strabo 17.1.31.

of Mendes,[23] or an ibis and a baboon of Hermopolis),[24] has ever been identified archaeologically, but it is usually suggested that they resided within the corresponding temple proper. Indeed, the recent excavations at Elephantine by the German Archaeological Institute and the Swiss Institute (from autumn 2013 to spring 2014) discovered a building complex south of the Khnum temple composed of an isolated chamber (about 3.6 m wide and 4.3 m deep) and a courtyard (10 m wide and 15 m long) in front of it. In addition, 'a short, slightly curved passage at the north-eastern corner of the court gave direct access to the side entrance of the temple of Khnum'.[25] This area is therefore identified as a house of the sacred ram of Khnum, whose burial ground was found, on the opposite, northern side of the temple,[26] in a relative position similar to that of the two excavated ram cemeteries at Mendes.[27]

Alan B. Lloyd argues that the sanctuary of Apis possibly stood outside the temenos walls of the Ptah precinct.[28] This seems unlikely considering the close theological ties of the sacred bull and the god Ptah, and also keeping in mind the recent discovery described above at Elephantine. Indeed, a stela dated to the second year of Nectanebo II (Cairo JE 40002 l. 3-4; 358 B.C.) records the rebuilding of the Place of Apis 'at the temple of his father Ptah' (*r ḥwt-nṯr n.t ỉt=f Ptḥ*).[29] Furthermore, in Ptolemaic times the two temples are even regarded as one.[30] Thus, its location has to be inside the Ptah temple temenos walls, certainly within the southwestern sector of the temple enclosure where the Place of Embalmment (*wꜥb.t*) has already been identified (see below).[31] In the most recent reconstruction, Pierre Meyrat placed the bull's living quarters to the south of the Place of Embalmment, towards the north face of the Ptah temple enclosure wall which had been rebuilt, probably on a line with the former Ramesside wall, by the Ptolemaic era at the latest.[32] On the other hand, it seems unlikely that the living quarters of the Apis bulls stood in such a limited space, bearing in mind the location of the small chapel of Seti I (c. 1290-1279 B.C.) and Ramses II (c. 1279-1212 B.C.) directly across the wabet. These were still in use during the reigns of the Nubian kings Shabaka (c. 716-702 B.C.) and Taharqa (690-664 B.C.), and perhaps much later, since blocks bearing Shabaka's and Taharqa's names were found reused in the later construction.[33] The Nubian kings also bestowed the precinct of Apis with rich gifts.[34] Moreover, it is now certain that the Place of Embalmment formed only a part of the Place of Apis itself. On the west side of the alabaster basin of the lion libation bed no. 4, found at the easternmost end of Room A, a short hieroglyphic inscription reads 'the wabet [of] the temple of Apis' (*wꜥb.t* [*n.t*] *ḥwt-nṯr n.t Ḥp*).[35] The remains on the site strongly indicate a building phase from the reign of Ramses II to Darius I and reconstruction works undertaken by the 25th and the 26th Dynasty rulers; however, the sanctuary was then completely rebuilt under Nectanebo II.[36]

23 Redford and Redford (2005), pp. 169-170.
24 Kessler and Nur el-Din (2005), pp. 127-130.
25 Arnold *et al.* (2014), pp. 13-14.
26 Delange and Jaritz (2013).
27 Redford and Redford (2005), pp. 170-184.
28 Lloyd (1988), p. 135.
29 Quibell (1909), p. 90.
30 BGU VI 1216, 52-53 and 190-191 (110 B.C.?); cf. Hoogendijk (2012), p. 151.
31 Jones (1990), pp. 141-145.
32 See Meyrat (2014a), p. 259. For the course of the enclosure wall and its date, see Jeffreys (1985), pp. 23, 65, fig. 15.
33 Cf. Leclant (1951), p. 346; Habachi (1979), p. 50; Leclant (1981), pp. 289-290, Taf. 44a-b; Jeffreys (1985), pp. 73-74.
34 See Vercoutter (1960), pp. 62-76. For activities of the Nubian kings in the Memphite area, see Pope (2014), pp. 262-264.
35 Jones (1990), p. 146.
36 Jones (1990), p. 147.

Layout of the sanctuary

The Place of Embalmment

The Place of Embalmment (*wꜥb.t*) is the only part of the sanctuary still visible within the south-western corner of the Ptah temples enclosure at Memphis. It is located on the north side of the main road from Bedrashein to Saqqara. The interior of the building consists of four long, narrow, parallel transverse rooms (A, B, C, D), connected by a passage starting at the extreme east end of the building.[37] South of Room D, called the South Area (today badly ruined),[38] are several preserved architectural features which indicate that this sector might have been the location of the central hall of the Place of Embalmment (*wsḫ.t ꜥꜣ.t tꜣ wꜥb.t*), mentioned in both P. Wien KHM ÄS 3873 (rt. IV, 20),[39] and the donation stela of Nectanebo II.[40] Two groups of massive limestone blocks appear to have been foundations of doorways lying on an east-west axis,[41] leading to the rest of the sanctuary situated to the east (see below), and the remains of a colonnade comprising four columns in a line, found by Petrie,[42] perhaps represented 'the fir-tree ceiling' (*pꜣ kp ꜥš*), i.e. the southern entrance of the Place of Embalmment.[43] The monolithic calcite Table 4 (1.20m x 3.07m x 5.40m) is the finest and least damaged among several others found within the building either whole, below the pavement of Room A (Table 3),[44] or split into four (Table 1),[45] or into two pieces (Table 2); Table 2 is dedicated by King Amasis (570-526 B.C.).[46] It lies at the east end of Room A and was very likely used during the embalming ritual; its spouts and drainage channels were designed to carry off either bodily fluids or libations.[47] Table 4 apparently belongs to a later building phase,[48] and is possibly contemporary with a large mudbrick platform built of casemate walls with a loose fill between them to the north of the Place of Embalmment.[49] A hoard of silver coins, found within loose mudbrick debris of the platform, indicate that it was constructed around the mid-fourth century B.C.,[50] which coincides with the rebuilding of the sanctuary by Nectanebo II.[51]

The Stall

In a passage of P. Wien KHM ÄS 3873, while describing the construction of a temporary tent outside the southern door of the Place of Embalmment, the scribe also mentions that this tent 'is open [to] the stall (*pꜣ ỉhj*) [and] the south wall of the Place of Apis (*tꜣ ḏꜣi.t rsy*(*.t*) *tꜣ s.t Hp*)' (rt. IV 10).[52] Therefore, it is possible that the stall formed a part of the Place of Apis in addition to the Place of Embalmment. According to the passage, the stall had east and west doors (rt. IV 10-12): 'They [the priests] open the door which is in the east wall of the stall; they come

37 Jones and Milward Jones (1982), pp. 52-53; Jones and Milward Jones (1983), pp. 33-36; Jones and Milward Jones (1985), pp.21-28; Jones and Milward Jones (1987), pp. 37-44; Jones and Milward Jones (1988), pp. 111-116.
38 Jones and Milward Jones (1983), p. 36.
39 Vos (1993), pp. 53, 164.
40 Quibell (1909), p. 91.
41 Jones and Milward Jones (1983), p. 36.
42 Petrie (1908), p. 10 (29), pl. XXX; Jeffreys (1985), fig. 25.
43 Meyrat (2014a), p. 249.
44 Jones and Milward Jones (1982), p. 52.
45 Jones and Milward Jones (1982), p. 53.
46 Jones and Milward Jones (1982), p. 53.
47 Jones and Milward Jones (1982), pp. 52-54.
48 Jones and Milward Jones (1983), p. 39.
49 Jones and Milward Jones (1983), p. 38.
50 Jones and Milward Jones (1988), p. 116.
51 Jones (1990), p. 147.
52 Vos (1993), pp. 51, 249.

Fig. 3. Alabaster embalming table 4, looking south-east, at the Place of Embalmment (photo courtesy of Alain Guilleux).

Fig. 4. Detail of the alabaster embalming table 4, looking north-west, at the Place of Embalmment (photo courtesy of Alain Guilleux).

out from it after they found him [Apis] in the 23th Year of Pharaoh Amasis (548 B.C.), may he live, be prosperous and healthy, whereas it is from the door which is built in the west wall of the stall that they came out in the 12th Year of Pharaoh Apries (578 B.C.), may he live, be prosperous and healthy'.[53] The west door was apparently opened when a bull died (the official royal stela Louvre, IM 132, confirms the burial in 578 B.C.),[54] and the east door was most probably used when a new bull was found or more likely enthroned,[55] and very likely stood on the same axis. The general direction of the burial ritual itself must, therefore, have been formulated primarily due to practical reasons, in order to fit within the physical arrangement of the existing buildings. Since the deceased bull was rapidly removed from the stall to the central hall of the Place of Embalmment (rt. IV, 20: *wsḫ.t ꜥꜣ.t tꜣ wꜥb.t*),[56] those two places most certainly shared the same wall and must have been part of the same building complex. Mourning lamentations were made throughout the central hall of the Place of Apis (rt. 0, 12: *wsḫ.t ꜥꜣ.t tꜣ s.t Ḥp*),[57] when a bull had died, before the embalming process began. As the lamentations are mentioned following the removal of the bull's corpse through the door in the west wall of the stall, these two rooms certainly could not be the same.[58] Furthermore, foundations of a doorway, found in the eastern wall of the Place of Embalmment,[59] perhaps served this purpose, strongly indicating that the rest of the sanctuary of Apis was located further to the east.

The general direction of burial processions corroborates such a possibility. When the mummy of a bull was ready it was brought out of the Place of Embalmment to the stall, where the naos of the sacred barge was waiting. Then the bull's mummy was placed on a wheeled wagon. At the same time, the doorway in the east wall of the stall was opened for the funerary wagon to pass through, most probably in the direction of the southern pylon tower of the Ptah temple enclosure which once stood some 160 m southeast of the Place of Embalmment, behind the now fallen colossus of Ramses II. This moment is perhaps recorded on a stela of Nectanebo II (Cairo JE 40002 l. 18): 'After his divinity [the dead bull] came opposite the great double-door, he [Apis] found his Majesty [king] standing among his [the bull's] followers…' (*jr m-ḫtj jnṯr=f m-ꜥḳꜣ rw.tj-wr.tj gm.n=f ḥm=f ꜥḥꜥ(w) m šmsw=f*).[60] Just beyond the southern gateway ran the sacred way to the south, which remained in use until Ptolemaic times.[61] The area along the southeastern line of the enclosure wall was an important sacred space in the Late Period and most probably contained the smaller superstructures, perhaps chapels. A fragment of the statue of Udjahorresnet, an important state official who lived between the reigns of Amasis and Darius I, was found reused in a brick building possibly in the late Ptolemaic/early Roman times, but it is plausible that it once stood in one of the smaller sanctuaries subsidiaries to the enclosure of Ptah.[62]

The wheeled funerary wagon left the Place of Embalmment via the west door of the stall (that is, the east door of the Place of Embalmment), and passed through the east door towards the south-

53 Vos (1993), pp. 51, 154-156, 249, 280; for additional comments, see Quack (1994), pp. 188-189; reading 'the year 23 of Pharaoh Amasis' is according to Devauchelle (2011), pp. 144-145.

54 Chassinat (1900), p. 167 xc.

55 See Devauchelle (2011), p. 144, n. 34. A bull found in 548 B.C. is not known from other sources. Indeed, the official royal stela records the biography of the Apis bull, which died in the same year. If a new bull was found shortly afterwards, it was probably short-lived, since the next bull was born or enthroned in 544 B.C. and buried under the Persian king Cambyses II in 525 B.C.

56 Vos (1993), pp. 53, 164.

57 Meyrat (2014b), pp. 266, 268.

58 See map in Meyrat (2014a), p. 259.

59 Jones and Milward Jones (1983), p. 36.

60 Quibell (1909), p. 91.

61 Jeffreys (1985), p. 75.

62 Anthes (1965), p. 34; Bareš (1999), p. 42.

ern pylon. A vague passage in P. Wien KMH ÄS 3873 indicates that one of these doors was known as the Portal of the Horizon (rt. IV, 20: *sbẖ.t ꜣẖ.t*), closely associated with the great hall of the Place of Embalmment.[63] Vos argues that this door has to be located at the place where the sun arises to symbolize the god's cosmic resurrection.[64] Thus, the Portal of the Horizon cannot be placed at the southern entrance of the Place of Embalmment as previously believed. Also, the presence of the priests of the House of the Inundation of the Nile (*Pr-Ḥꜥpj*) beyond this door, who apparently threw the brick (*tb.t*) in front of the wagon to prevent it from advancing,[65] further indicates the possibility that this door was the same as the west door of the stall/east door of the Place of Embalmment. Another possibility is that the Portal of the Horizon is the very entrance of the stall. Their care for a newly-found sacred bull justifies their participation in resurrection ceremonies of a deceased bull. Beside the eastern door of the stall apparently stood the Pavilion of Appearances (rt. IV, 14-15), where the wheeled funerary wagon was drawn in by the wab priests on its way out of the sanctuary, while gathered mourners raised a great lamentation.[66]

The Pavilion of Appearances

Another notable architectural feature of the Place of Apis should be mentioned here: an outer courtyard with a colonnade. When Herodotus (c. 484 - c. 424 B.C.) visited the precinct of Apis in the fifth century B.C., he said that Psammetichus I built a southern gateway to the temple of Ptah and a courtyard for Apis in front of it, surrounded by a colonnade, which rested upon colossal statues, twelve cubits (c. 5.30 m) in height, instead of columns.[67] At the beginning of the Roman era, Strabo (c. 64B.C. – after 21A.D) positioned a courtyard in front of the sanctuary of Apis, together with a sanctuary for its mother cow.[68] Since there is no precisely dated surviving evidence of Psammetichus I's building activities within the city,[69] very likely due to circumstances of preservation of known monuments there, it is usually considered that this gateway was set in the south temenos wall which once stood behind the fallen colossus of Ramses II.[70] This would be the same probably mentioned on a stela of Nectanebo II as an exit point for the burial procession. However, it is possible that Psammetichus I's gateway was located further to the north, forming the southern entrance of the main temple complex of Ptah instead of the enclosure. If so, it is logical that the sanctuary of Apis could have been attached to the presumed southern courtyard between two pylons of the temple complex. The existence of such a courtyard is supported by the discovery of several private statues dated to the reign of Psammetichus I and later times in the area of the colossus of Ramses II,[71] which indicate that this area was indeed publicly accessible, at least as a depository for private dedications of the Memphite elite. Its position is also suitable as a location where ordinary Egyptians and non-Egyptian visitors like Herodotus or later Strabo would have

63 Vos (1993), p. 53.

64 Vos (1993), pp. 41, 168. Early Roman papyri (P. Rhind 1, II d 8, IV d 10, P. Rhind 2, III d 7) suggest that *sbẖ.t ꜣẖ.t* is rather a synonym for *pr-nfr*, another term for the embalming place (Wb I, p. 517; Erichsen (1954), p. 133; see also Donohue (1978), pp. 143-148; references are courtesy of Pierre Meyrat). But see in Jurman (2010), p. 253, who states that in the Apis Embalming ritual and on the Serapeum stelae, except in one attestation from the Nineteenth Dynasty, the term *pr-nfr* does not occur at all. The Place of Embalmment is always rendered as wabet. Accordingly, there is a possibility that *sbẖ.t ꜣẖ.t* in sense of the Apis Embalming Ritual indeed refers to a specific architectural feature. For *sbẖ.t*, see also Spencer (1984), p. 161.

65 This act symbolizes the resurrection of Apis. Cf. Vos (1993), p. 41.

66 Vos (1993), p. 52.

67 Hdt. 2.153.

68 Strabo 17.1.31.

69 See Málek (1986), p. 111, n. 89.

70 Lloyd (1988), p. 136.

71 Three statues are mentioned in Málek (1986), p. 109. For other examples of statues from the 26th Dynasty found in the same area, see PM III², pp. 838-839.

entered the Ptah temple precinct to see the Apis bull within his courtyard. This would only have happened on certain days since the daily cultic performances within the temple temenos walls were of a restricted nature and usually not accessible to the wider populace.[72]

Fig. 5. Limestone relief most likely from the sanctuary of Apis at Memphis, present-day location unknown (© Griffith Institute, University of Oxford).

The question of column types can be helpful as well. Since Herodotus described columns like caryatids, Lloyd argues that his description could only refer to Osirian pillars,[73] but no traces of such pillars were ever found within the temple of Ptah. One possible reason no Osirian pillars have been found is that they may have been made of wood, but another is that they may have been a different type of column.[74] In the area to the east of the Place of Embalmment towards the colossus of Ramses II a column with a Hathor capital was found, but unfortunately without clear archeological context and certainly not *in situ*.[75] There is evidence that a small Ramesside Hathor temple, apparently disused after the end of the New Kingdom and located south-west of the southern gateway of the Ptah temple enclosure, had been quarried for building material in the Late Period: at some point its eastern pylon and eastern courtyard had been removed and later replaced by a brick building (perhaps a workshop of some kind).[76] Material from this site could have been reused in building a courtyard for the Apis bull. The association with the goddess Hathor came probably through the Mother of Apis cows, which were mentioned by their distinctive names for the first known time in the inscriptions under Amasis.[77] Initially, the Mothers of Apis cows lived, died and

72 See Spalinger (1998), pp. 241-260.

73 Lloyd (1988), p. 136; see also Meyrat (2014a), p. 258. For the Osirian pillars and their usage in the context of the royal mortuary temples, see Leblanc (1980), pp. 69-89.

74 Meyrat (2014a), p. 258.

75 Jeffreys (1985), p. 98, n. 205.

76 Jeffreys (1985), pp. 25-26.

77 The earliest known inscription of the Mother of Apis (71/2-5 [5273]; cf. Smith, Andrews and Davies (2011), pp. 15-25) refers to a series of events occurring to several Mothers of Apis cows between 534 B.C. and 463 B.C. at the latest. The inscription were buried within the precinct of Hathor, the Lady of the Sycomore (*Pr-nb.t-nhy.t*), which was most probably located somewhere south of Memphis,[78] before their stall and sanctuary were moved to a courtyard in front of the sanctuary of their offspring, and their burial place to North Saqqara at the remote vicinity of the Serapeum. This change certainly occurred in the later part of the First Persian Period.[79] The close theological connection of the Mother of Apis cows with Hathor had been replaced by the 29th Dynasty (399-381 B.C.), when Isis appears in surviving inscriptions as the Mother of Apis and has remained so ever since.[80]

Identification of a courtyard in front of the sanctuary of Apis with the Pavilion of Appearance of the papyri is indeed possible. According to Quack, the usage of the word *šst* indicates the place where the sacred animals had spent their lifetimes and died.[81] Also, according to the Book of the Temple, a manual for the architecture of the ideal Egyptian temple and the duties of its priests and other employees, the sacred animal was happy if it could see the sun.[82] Thus, the Pavilion of Appearances has to be an edifice open to the sky. In the case of the Apis bull, the Pavilion of Appearance was located beyond the entrance to the sanctuary of Apis as was stated in P. Wien KHM ÄS 3783. In addition, important news like the death of the Apis bulls was announced outdoors to gathered people. Strabo also mentioned the window on the sanctuary. Through this window the bull could be seen.[83] Strabo adds that visitors prefer to see the Apis bull outside thus indicating the distance between their standpoint and the sanctuary itself. Since the word *šst* is a late writing of *sšd* 'window, the window of appearances',[84] it seems plausible that Strabo's window represents an opening on the sanctuary and it is reasonable to conclude that this window overlooked a courtyard in front of it.

Conclusion

The Place of Apis or the Place of Installation of the living Apis was located inside the walls of the temple enclosure of Ptah at Memphis. The sanctuary was apparently composed of three architectural features: (1) the Pavilion of Appearances or an open courtyard with a colonnade, described by Herodotus and later Strabo, where initiated Egyptians and non-Egyptian visitors could see the Apis bull; (2) the stall, where the Apis bulls spent their lifetimes and died; and (3) the Place of Embalmment, where the dead bulls were wrapped into linen and prepared for the funerary procession. The sanctuary was built along an east-west axis, the Pavilion of Appearances being its

indicates that the Mothers of Apis cows were indeed known even before the reign of Amasis. The inscription must have been compiled from some older written sources as late as the end of the reign of the Persian king Artaxerxes I (424/423 B.C.), possibly to commemorate the decision to move their resting place from Memphis to North Saqqara afterwards. Such a decision was probably made due to some serious disturbances in Memphis during the later part of the First Persian Period.

78 Smith (1988), pp. 188-191.

79 The place for their initial burials in the later part of the First Persian Period was probably located in the cliff behind the sanctuary of Isis (Sanctuary A) of the Main Temple Complex of the Sacred Animal Necropolis at North Saqqara, known as the Vault complexes A, B and D. The inscriptions concerning burials made within the Mother of Apis Catacombs, located in the North Enclosure of the Main Temple Complex (Sector 2), began continuously with the preparations for the interment of Taamon (I) in 392/391 B.C. and ended with apparent abandonment of the vaults sometime after 41 B.C. (Cf. Davies (1998), p. 49, Davies (2006), p. 48; Smith, Andrews and Davies (2011), pp. 3-11, 269-278).

80 The association of Isis and Apis could have been of an earlier date: the middle or lower register of a group of the Carian stelae from Saqqara dated to the sixth and fifth centuries B.C. usually shows the Apis bull standing on a pedestal being flanked by either Isis and Thoth or the dedicator. For the Carian stelae, see Vittmann (2003), pp. 170-174.

81 Quack (1997/1998), p. 51, n. 32; Quack (2000), p. 5; Quack (2003a), pp. 113, 118-123; Quack (2003b), p. 14; Quack (2004), pp. 15-25. See also Meyrat (2014b), pp. 274-275.

82 Quack (2000), p. 5; Quack (2003b), p. 14.

83 Strabo 17.1.31.

84 *Wb* IV, pp. 301-302.

eastern-most, and the Place of Embalmment its western-most end. Between these two features lay the stall, where the Apis bulls spent their lifetimes venerated as living heralds of the god Ptah. Finally, the Pavilion of Appearances was attached to the presumed southern open courtyard which very likely lay between two pylon-gates of the Ptah temple enclosure, therefore making the sanctuary of Apis publicly accessible.

Bibliography

Aly, M. I. (2006), 'Documents inédits provenant des petits souterrains du Sérapéum de Memphis', *MDAIK* 62, pp. 43-61.

Anthes, R. (1965), 'General report on the excavation', in R. Anthes (ed.), *Mit Rahineh 1956*, Philadelphia: University Museum, pp. 1-44.

Arnold F. *et al.* (2014), 'Report on the Excavations at Elephantine by the German Archaeological Institute and the Swiss Institute from autumn 2013 to spring 2014', <https://www.dainst.org/projekt/-/project-display/25953#_LFR_FN__projectdisplay_WAR_daiportlet_view_downloads> (18/10/2016).

Bareš, L. (1999), *Abusir IV: The Shaft Tomb of Udjahorresnet at Abusir*, Prague: The Charles University Press.

Bresciani, E. (1983), 'Note di Toponomastica: I Templi di ***Mn-Nfr, Wn-Ḫm, Pr-Ḥʿpj-mḥt***', *EVO* 6, pp. 67-73.

Burton, A. (1972), *Diodorus Siculus, Book I. A Commentary*, Leiden: Brill.

Chassinat, É. G. (1900), 'Textes provenant du Sérapéum de Memphis', *RT* 22, pp. 9-26, pp. 163-180.

Davies, S. (1998), 'Uncharted Saqqara: A Postscript', *JEA* 84, pp. 45-56.

Davies, S. (2006), *The sacred animal necropolis at North Saqqara: The mother of Apis and baboon catacombs. The archaeological report*, London: The Egypt Exploration Society.

Delange, E. and H. Jaritz (2013), *Elephantine XXV: der Widderfriedhof des Chnumtempels*. Wiesbaden: Harrassowitz.

Devauchelle, D. (1994), 'Notes et documents pour servir à l'histoire du Sérapéum de Memphis (I-V)', *RdÉ* 45, pp. 75-86.

Devauchelle, D. (1998), 'Une invocation aux dieux du Sérapéum de Memphis', in W. Clarysse, A. Schoors and H. Willems (eds.), *Egyptian Religion. The Last Thousand Years. Studies dedicated to the memory of Jan Quaegebeur*.Leven: Peeters, pp. 589-611.

Devauchelle, D. (2010), 'Osiris, Apis, Sarapis et les autres. Remarques sur les Osiris memphites au I[er] millénaire av. J.-C.', in L. Coulon (ed.), *Le culte d'Osiris au Ier millénaire av. J.-C. Découvertes et travaux récents*, Cairo: IFAO, pp. 49-62.

Devauchelle, D. (2011), 'La XXVIe dynastie au Sérapéum de Memphis', in D. Devauchelle (ed.), *La XXVI[e] dynastie: continuités et ruptures*, Paris: Editions Cybele, pp. 139-152.

Devauchelle, D. (2012), 'Pas d'Apis pour Sarapis', in A. Gasse, F. Servajean and Chr. Thiers (eds), *Et in Ægypto et ad Æegyptum. Recueil d'études dédiées à Jean-Claude Grenier*, Montpellier: Université Paul Valéry-Montpellier III, pp. 213-225.

Dodson, A. (2005), 'Bull Cults', in S. Ikram (ed.), *Divine Creatures. Animal Mummies in Ancient Egypt*, Cairo: American University in Cairo Press, pp. 72-105.

Donahue, V. A. (1978), 'Pr-nfr', *JEA* 64, pp. 143-148.

Erichsen, W. (1954), *Demotisches Glossar*, Copenhagen: EinarMunksgaard.

Farid, A. (1997), 'Zwanzig demotische Apisinschriften', *MDAIK* 53, pp. 23-56.

Gorre, G. (2009), *Les relations du clergé Égyptien et des lagides d'après les sources privées*, Leuven: Peeters.

Habachi, L. (1979), 'New Light on Objects of Unknown Provenance. III: A Head of Queen Touy and a Block of Shabaka Now Kept in Museum Abroad', *GM* 31, pp. 47-53.

Hermann, A. (1960), 'Der letzte Apisstier', *Jahrbuch für Antike und Christentum* 3, pp. 34-50.

Hoogendijk F.A.J. (2012), 'Maternal Division of Housed Property near the Temples of Memphis', in Cuvigny H., Hickey T. M., Ast R., Lougovaya J. (eds.), *Papyrological Texts in Honor of Roger S. Bagnall*, Durham, NC: The American Society of Papyrologists, pp. 149-158.

Jeffreys, D. (1985), *The Survey of Memphis I. The Archaeological Report*, London: The Egypt Exploration Society.

Jones, M. (1990), 'The Temple of Apis in Memphis', *JEA* 76, pp. 141-147.

Jones, M. and Milward Jones, A. (1982), 'The Apis House Project at Mit Rahinah: first season, 1982', *JARCE* 19, pp. 51-58.
Jones, M. and Milward Jones, A. (1983), 'The Apis House Project at Mit Rahinah Preliminary Report of the second and third Seasons, 1982-1983', *JARCE* 20, pp. 33-45.
Jones, M. and Milward Jones, A. (1985), 'Apis expedition at Mit Rahinah: preliminary report of the fourth season, 1984', *JARCE* 22, pp. 17-28.
Jones, M. and Milward Jones, A. (1987), 'The Apis House Project at Mit Rahinah: preliminary report of the fifth season, 1984-1985', *JARCE* 24, pp. 35-46.
Jones, M. and Milward Jones, A. (1988), 'The Apis House Project at Mit Rahinah: preliminary report of the sixth season, 1986', *JARCE* 25, pp. 105-116.
Jurman, C. (2010), 'Running with Apis. Memphite Animal Cults as a Point of Reference for Social and Religious Practices in Late Period Elite Culture', in L. Bareš, F. Coppens, K. Smoláriková (eds.), *Egypt in transition. Social and Religious Development of Egypt in the First Millennium B.C.. Proceedings of a Conference Held at Prague, 1st-4th September 2009*, Prague: Charles University Press, pp. 224-267.
Kessler, D. (1989), *Die heiligen Tiere und der König. Teil I: Beiträge zu Organisation, Kult und Theologie der spätzeitlichen Tierfriedhöfe*, Wiesbaden: Harrassowitz.
Kessler, D. and A. Nur el-Din (2005), 'Tuna al-Gebel: millions of ibises and other animals', in S. Ikram (ed.), *Divine creatures: animal mummies in ancient Egypt*, Cairo; New York: American University in Cairo Press, pp. 120-163.
Krauss, R. (2007), 'Die Mahler-Borchardtsche These über die Apis-Inthronisationen bei Vollmond', *Acta Praehistorica et Archaeologica* 39, pp. 339-348.
Leblanc, Ch. (1980), 'Piliers et colosses de type "osiriaque" dans le contexte des temples de culte royale', *BIFAO* 80, pp. 69-89.
Leclant, J. (1951), 'Compte rendu des fouilles et travaux menés en Égypte durant les campagnes, 1948-50. III.', *Orientalia* 20, pp. 343-351.
Leclant, J. (1981), 'Varia Aethiopica', *MDAIK* 37, pp. 289-297, Taf. 44.
Leclère, F. (2008), *Les villes de Basse Égypte au Ier millénaire av. J.-C. Analyse archéologique et historique de la topographie urbaine*, Cairo: IFAO.
Lloyd, A. B. (1988), *Herodotus Book II. Commentary 99-182*, Leiden: Brill.
Málek, J. (1986), 'The Monument Recorded by Alice Lieder in the "Temple of Vulcan" at Memphis in May 1853', *JEA* 72, pp. 101-112.
Meyrat, P. (2014a), 'Topography-related Problems in the Apis Embalming Ritual', in J. F. Quack (ed.), *Ägyptische Rituale der griechisch-römischen Zeit*, Tübingen: Mohr Siebeck, pp. 247-262 and plate available here: <https://sites.google.com/site/pierremeyrat/Home/publications>.
Meyrat, P. (2014b), 'The First Column of the Apis Embalming Ritual Papyrus Zagreb 597-2', in J. F. Quack (ed.), *Ägyptische Rituale der griechisch-römischen Zeit*, Tübingen: Mohr Siebeck, pp. 263-337, and transcription available here:<https://sites.google.com/site/pierremeyrat/Home/publications>.
Otto, E. (1938), *Beiträge zur Geschichte der Stierkulte in Ägypten*, Leipzig: Hinrichs.
Panov, M. V. (2015), *Источники по истории жреческих семей Мемфиса и Летополя в поздний период*, Novosibirsk: M. V. Panov.
Pope, J. (2014), *The Double Kingdom under Taharqo. Studies in the History of Kush and Egypt, c. 690-664 BC*, Leiden/Boston: Brill.
Quack, J. F. (1994), 'Reznesion: The Apis Embalming Ritual', *Enchoria* 21, pp. 186-191.
Quack, J. F. (1995), 'Zwei Handbücher der Mumifizierung im Balsamierungsritual des Apisstieres', *Enchoria* 22, pp. 123-129.
Quack, J. F. (1997/1998), 'Beiträge zum Verständnis des Apisrituals', *Enchoria* 24, pp. 43-53.
Quack, J. F. (2000), 'Das Buch vom Tempel und verwandte Texte: ein Vorbericht', *ARG* 2, pp. 1-20.
Quack, J. F. (2003a), 'Die Rolle des heiligen Tieres im Buch vom Tempel', in M. Fitzenreiter (ed.), *Tierkulte im pharaonischen Ägypten und im Kulturvergleich*, Berlin: Wilhelm Fink Verlag, pp. 111-123.
Quack, J. F. (2003b), 'Le Manuel du Temple, une nouvelle source sur la vie des prêtres égyptiens', *EAO* 29, pp. 11-18.
Quack, J. F. (2004), 'Organiser le culte idéal. Le Manuel du Temple', *BSFE* 160, pp. 11-25.
Quibell, J. E. (1909), *Excavations at Saqqara (1907-8)*, Cairo: IFAO.

Quirke, S. and Andrews, C. A. R. (1988), *The Rosetta Stone: facsimile drawing*, London: The British Museum Press.

Redford, S. and D. B. Redford (2005), 'The cult and necropolis of the sacred ram at Mendes', in S. Ikram (ed.), *Divine creatures: animal mummies in ancient Egypt*, Cairo; New York: American University in Cairo Press, pp. 164-198.

Simpson, W. K. (1957), 'A running of the Apis in the reign of 'Aha and passages in Manetho and Aelian', *Orientalia* 26, pp. 139-142.

Smith, H. S. (1988), 'A Memphite miscellany', in J. Baines, T. G. H. James, A. Leahy, and A. F. Shore (eds.), *Pyramid studies and other essays presented to I. E. S. Edwards*, London: Egypt Exploration Society, pp. 184-192.

Smith, H. S., Andrews, C. A. R. and Davies, S. (2011), *The Sacred Animal Necropolis at North Saqqara: The Mother of Apis Inscriptions*, London: The Egypt Exploration Society.

Spalinger, A. (1998), 'The Limitation of Formal Ancient Egyptian Religion', *JNES* 57/4, pp. 241-260.

Spencer, P. (1984), *The Egyptian Temple. A Lexicographical Study*. London: Kegan Paul International.

Thompson, D. J. (2012), *Memphis under the Ptolemies*, Princeton: Princeton University Press.

Vercoutter, J. (1960), 'The Napatan Kings and Apis Worship (Serapeum Burials of the Napatan Period)', *Kush* 8, pp. 62-76.

Vittmann, G. (2003), *Ägypten und die Fremden im ersten vorchristichen Jahrtausand*, Mainz: Verlag Philipp von Zabern.

Vos, R. L. (1993), *The Apis Embalming Ritual. P. Vindob. 3873*, Leuven: Peeters, 1993.

Wilkinson, T. A. H. (1999), *Early Dynastic Egypt*, London/New York: Routledge.

Les constructions axiales thoutmosides devant le 4e pylône de Karnak

François Larché

À la suite des travaux successifs de S. Sauneron, J. Vérité et J. Lauffray,[1] des sondages[2] ont été effectués par le Centre Franco-Égyptien d'Études des Temples de Karnak, d'abord en 1999-2000, puis en 2004 devant le 4e pylône du temple.[3] L'observation des vestiges, en élévation et en fondation, m'a déjà permis de proposer quatre études architecturales successives[4] qui, tout en ajoutant de nouveaux détails, en ont précisé les conclusions. Dans ce qui va suivre, des indices complémentaires permettent d'assurer l'emplacement des obélisques de Thoutmosis III sur les bases adjacentes au parement oriental du 3e pylône, là où la plupart de leurs fragments ont été découverts. Cette reconstruction repose sur le fac-similé de ces fragments qui ont tous été dessinés entre 1997 et 2004. Ensuite, l'encastrement de la chapelle en calcite d'Amenhotep II entre les obélisques de Thoutmosis Ier sera à nouveau expliqué, pour répondre à une critique mettant en cause cet emplacement sur la base d'un plan déformé, et par conséquent inexact, des vestiges archéologiques.

L'emplacement des obélisques de Maâtkarê-Thoutmosis II

La réalisation des dernières planches de la publication *La cour à portique de Thoumosis IV*[5] a nécessité d'observer à nouveau les deux fondations d'obélisque, découvertes sous les môles du 3e pylône, de part et d'autre de l'axe ouest-est (pls. 9, 19-34). Un détail particulier de leur lit d'attente a soulevé une question que j'avais simplement posée sur ces planches sans pouvoir y répondre de façon satisfaisante. En effet, un ressaut quadrangulaire, bien marqué sur l'arase de ces deux fondations, délimite la surface de la base en granite sur laquelle reposait chaque obélisque (pl. 34). Or, cette surface (3,14 x 3,24 m) est proche de celle de la base en granite sur laquelle repose toujours l'obélisque sud de Thoutmosis Ier (hauteur : 20 m), alors que cette surface est bien inférieure à celle des bases en granite adossées aux môles nord et sud du 3e pylône (pl. 19). Il devenait alors évident que des obélisques de section et donc de dimensions proches de ceux de Thoutmosis Ier avaient reposé sur les fondations recouvertes par le 3e pylône.

Ainsi, de très grands obélisques comme ceux de Thoutmosis III n'y avaient plus leur place pour les raisons qui vont suivre (pls. 14, 15). La surface du lit de pose de ces derniers obélisques est restituable (2,4 x 2,4 m) grâce à l'imposant fragment (dont le lit de pose est conservé) toujours placé

---

1 Sauneron et Vérité (1969), pp. 249-276 ; Lauffray (1980), p. 1-65.

2 Masson et Millet (2007), pp. 659-679.

3 Les sondages, les fac-similés et les photographies ont été faits par les équipes du CFEETK alors sous la direction N. Grimal et Fr. Larché de 1999 à fin 2004.

4 Larché (2007), pp. 407-499 ; Burgos et Larché (2008), p. 332 ; Larché (2010), pp. 297-326 ; Letellier et Larché (2014).

5 Letellier et Larché (2014), pls. 240, 241, 257, 258.5, 259.2.

en équilibre sur la base en granite nord (pl. 15), et également à l'aide du fragment n° 75 (pl. 14) de l'obélisque sud (largeur : 2,34 m). Un obélisque de cette section n'aurait pu être installé sur les fondations enfouies sous le 3e pylône. En effet, le plan des vestiges des deux paires d'obélisques placées entre les 3e et 4e pylônes (pl. 19) montre un très large débord de la base en granite au pourtour du fût de chaque obélisque. Ce débord important (~1 coudée) existe autour des obélisques de Maâtkarê entre les 4e et 5e pylônes aussi bien qu'autour de ceux de Thoutmosis III devant le 7e pylône. Au contraire, ce large débord n'existe pas sur l'ancien plan restitué[6] des obélisques placés à l'aplomb des fondations conservées sous le 3e pylône. La planche 33 de notre étude *La cour à portique de Thoutmosis IV* représente la restitution des obélisques de Thoumosis III (2,4 x 2,4 m), mais avec déjà ce point d'interrogation indiqué en légendes sur les autres planches.[7] En effet, la section de l'obélisque restitué de Thoutmosis III m'apparaissait déjà trop importante pour les fondations sous le 3e pylône (pls. 19, 34). Il devenait donc indispensable d'identifier un obélisque dont la section inférieure lui permette de reposer sur une base en granite ayant cette faible surface (3,14 x 3,24 m).[8]

Une troisième paire d'obélisques au nom de Maâtkarê-Thoutmosis II a été restituée par L. Gabolde[9] avec une très grande hauteur (28 m) et, par conséquent, une surface de leur lit de pose identique à celle des obélisques de Thoutmosis III, et ce, bien qu'aucun fragment de la base des deux fûts n'ait été identifié (pls. 10, 11). Cette grande surface du lit de pose reposait sur l'attribution hypothétique d'un fragment d bien conservé dont le texte semblait proche de la base du fût[10] (pl. 16). Or ce fragment d avait déjà attiré mon attention en raison du lieu de sa découverte par Legrain contre le parement sud de la base adossée au môle sud du 3e pylône[11] (pl. 7). Mais, surtout, sa largeur (2,323 m) était bien supérieure à celle d'un assemblage de six fragments attribué par L. Gabolde[12] aux obélisques de Maâtkarê-Thoutmosis II. Certains de ces fragments sont remployés en dalle de plafond du vestibule de la chapelle de Philippe Arrhidée (pls. 10, 11). En effet, les hiéroglyphes gravés sur cet assemblage forment la fin du texte qui est nécessairement proche de la base du fût de l'obélisque. Cet assemblage conserve deux longs joints parallèles, perpendiculaires à la face décorée qui, aujourd'hui, forme le sommet du plafond. Le joint de droite qui coupe partiellement la colonne de texte a certainement été taillé au moment du remploi du fragment d'obélisque en plafond. Le joint de gauche est distant de 79 cm de la colonne de texte, mais son appui contre la dalle voisine empêche de voir si sa face est lisse. Si c'était le cas, ce joint appartiendrait alors au parement perpendiculaire de l'obélisque, et cela permettrait de restituer la section de son fût à ce niveau à

---

6 Letellier et Larché (2014), pl. 241.

7 Letellier et Larché (2014), pp. 241-244, 248, 250-255 et 257.

8 Gabolde (1987), pp. 152-153. Il me semble que les bases en granite remployées devant le temple de Montou sont trop petites et beaucoup trop hautes pour des bases d'obélisque (base est : section 258 cm + hauteur de 183 cm, base ouest : section 270 cm + hauteur de 193 cm).

9 Gabolde (2003), pp. 447- 448.

10 Gabolde (2003), pp. 420, 447, fig. 1 : 'D'après notre restitution de la fin du texte, cette cassure était distante d'environ 5,66 m de la base'.

11 Larché (2007), pp. 472, 473 : 7.4. Le problème soulevé par le lieu de découverte des fragments : 'De nombreux fragments des obélisques de Thoutmosis III et de Maâtkarê-Thoutmosis II ont été découverts le long du parement oriental des môles du IIIe pylône. Dans l'hypothèse où les bases en granite accolées au IIIe pylône ont servi à supporter les obélisques de Thoutmosis III, il est parfaitement normal d'en trouver les fragments à proximité. Mais que faisaient donc au même endroit les gros fragments des obélisques de Maâtkarê-Thoutmosis II qui sont supposés avoir été renversés par Amenhotep III pour faire place au IIIe pylône ? Comme il semble improbable que ces obélisques de Maâtkarê-Thoutmosis II soient restés à terre entre les deux pylônes, il faut trouver une autre explication à la présence de certains de leurs gros fragments à cet endroit. Dans l'hypothèse où les obélisques de Maâtkarê-Thoutmosis II se seraient brisés au moment de leur abattage, les plus longs fragments auraient été entreposés, probablement au nord du IIIe pylône, alors que les plus petits auraient été remployés dans le remplissage des môles. Ces derniers fragments seraient réapparus au moment du dépeçage de la partie supérieure du pylône pour rouler sur son côté oriental, comme le montrent les photographies anciennes'.

12 Gabolde (2003), pp. 428, 429 et 449, fig. 3 : 'Deux nouveaux fragments remployés dans le plafond du sanctuaire de Philippe Arrhidée et se raccordant à des fragments entreposés dans les magasins sud'.

~4 coudées (79 + 52,5 + 79 = 212,5 cm). Cette section est comparable à celle de l'obélisque sud de Thoutmosis Ier qui, comme on l'a vu plus haut, aurait parfaitement convenu aux bases en granite reposant sur les fondations enfouies sous le 3e pylône. Cependant, on ne peut écarter l'hypothèse que ce joint gauche ait également été retaillé pour adapter le bloc à sa place dans le plafond de la chapelle. La distance entre le texte et l'angle de l'obélisque pourrait alors être égale ou supérieure à 79 cm.

Cette importante différence de section du fût entre les deux assemblages proposés par L. Gabolde[13] m'a mené à réexaminer comment celui-ci en est venu à attribuer le premier d'entre eux (sa figure 1[14]) à l'obélisque de Maâtkarê-Thoutmosis II :

- *Obélisque nord de Thoutmosis III* :[15]

  'Deux des côtés ont été surchargés de colonnes latérales de textes ramessides : le côté est (hiéroglyphes orientés à gauche, colonnes complètes) et le côté sud (hiéroglyphes orientés à droite, mais, sur cette dernière face, la gravure de Mineptah est restée inachevée et n'a concerné que le tiers supérieur du fût). De ce fait, ce monolithe est incompatible avec nos vestiges ; en effet, les hiéroglyphes de ces derniers sont orientés à gauche et, dans ce cas, soit il s'agirait de la face est (mais elle devrait porter des textes ramessides), soit il s'agirait de la face nord (mais son côté adjacent, à gauche, le côté est, devrait encore porter des textes ramessides, ce qui n'est pas le cas)'.[16]

- *Obélisque sud de Thoutmosis III* :

  'Des colonnes de textes ramessides avaient été ajoutées sur ses faces sud, est et nord, et très vraisemblablement aussi sur sa face ouest, celle que l'on découvrait en entrant, ce qui le rend assurément incompatible avec nos vestiges'.[17]

Si comme il le décrit, la face nord de l'obélisque sud (pl. 14a) a bien été surchargée d'une colonne de texte ramesside de part et d'autre du texte axial thoutmoside,[18] les deux autres faces est et sud (la face ouest ayant disparu) ne possèdent que le texte axial thoutmoside (pl. 14c+d, à l'exception du sommet du nom d'Horus ajouté). Il me semble que L. Gabolde a proposé une restitution illogique. En effet, il est fort probable que, comme pour l'obélisque nord (pl. 15b), la face ouest de l'obélisque sud (pl. 14b) n'ait pas été surchargée de textes ramessides, et cela pour la bonne raison qu'après la construction du 3e pylône par Amenhotep III, les faces ouest des obélisques adossés à ses môles étaient moins visibles, à l'exception peut-être de leur sommet. On ne peut donc plus éliminer de la face ouest de l'obélisque sud de Thoutmosis III (pls. 14b, 16) l'assemblage b+c+d attribué par L. Gabolde à Maâtkarê-Thoutmosis II.[19]

Comme sur l'obélisque nord de Thoutmosis III (pl. 15), il est possible que les textes ramessides de la face nord de l'obélisque sud (pl. 14a) n'aient été gravés que sur le tiers supérieur du fût. Cependant, dans l'hypothèse où les textes ramessides ont été gravés jusqu'en bas de la face nord du fût, l'absence de hiéroglyphes sur les petites surfaces conservées des faces perpendiculaires à la face inscrite du fragment d (pls. 14b, 16) ne prouve pas l'absence de texte ramesside. En effet, comme on le

13 Gabolde (2003), p. 421 (7.8. Thoutmosis III, obélisques du 4e pylône), pp. 447-448, figs. 1 et 2.
14 Gabolde (2003), p. 447.
15 La face nord de l'obélisque nord et la face sud de l'obélisque sud étant particulièrement endommagées, il est probable que l'obélisque nord ait basculé vers le nord et l'obélisque sud vers le sud.
16 Gabolde (2003), p. 421.
17 Gabolde (2003), p. 421.
18 Au moins dans sa partie supérieure, comme le montre le fragment 1 placé sous le pyramidion (pl. 14c+d), et probablement sur le tiers supérieur du fût comme pour l'obélisque nord (pl. 15c+d).
19 Gabolde (2003), p. 447, fig. 1.

voit sur la face est de l'obélisque nord (pl. 15d), ce texte ramesside conserve une largeur uniforme sur toute sa hauteur, alors que la surface lisse le séparant de l'angle de l'obélisque s'élargit vers le bas en raison du talus des parements de l'obélisque. Le fragment d (pls. 14b, 16) étant proche de la base de l'obélisque en raison de sa grande largeur (232,3 cm), il est possible que les vestiges sans décoration des parements perpendiculaires aient bordé le texte ramesside qui n'aurait pas été conservé ici.

Cette réattribution, à la suite de Legrain,[20] du fragment d à la face ouest de l'obélisque sud de Thoutmosis III (pls. 14b, 16) permet de supprimer cet assemblage des obélisques de Maâtkarê-Thoutmosis II et, par conséquent, de diminuer leurs dimensions (section et hauteur) de façon à ce que ces derniers puissent reposer sur les petites bases en granite dont l'empreinte est visible sur les deux fondations d'obélisques enfouies sous le 3ᵉ pylône (pl. 34).

Proposition de chronologie des trois paires d'obélisques

Les obélisques de Thoutmosis Iᵉʳ

On pourrait supposer que Thoutmosis Iᵉʳ fit préparer une paire d'obélisques devant être dressés devant le 5ᵉ pylône. Cependant ces obélisques n'y furent jamais installés et restèrent au sol. Comme il est hasardeux de voir dans la grande fosse remplie de sable découverte devant le môle nord du 5ᵉ pylône la préparation d'une fondation d'obélisque,[21] il me semble que l'hypothèse suivante soit plus plausible.

Une dédicace gravée sur la face ouest de l'obélisque sud de Thoutmosis Iᵉʳ décrit leur emplacement (pls. 6, 7) : 'Ériger pour lui (Amon) deux obélisques à la *rw.ty* du temple'. L'emplacement de cette *rw.ty* du temple a été assimilé à la porte du 4ᵉ pylône parce que les obélisques de Thoutmosis Iᵉʳ se dressaient devant. Mais le terme *rw.ty* est aussi inscrit ailleurs, principalement sur l'axe sud :

- Sur le linteau extérieur de la grande porte sud[22] d'Amenhotep Iᵉʳ (pls. 2, 5).
- Sur une niche de mât du môle sud du 8ᵉ pylône (pl. 35).
- Sur les deux blocs en calcaire remployés dans l'élévation du môle est du 5ᵉ pylône et qui proviennent du chambranle d'une niche de mât (pl. 5).
- Sur le texte décorant un des obélisques de la Grande Offrande de Thoutmosis III, mais on ne sait si cet obélisque représente ceux du 4ᵉ ou du 7ᵉ pylône.[23]

Comme me l'a fait remarquer Ch. Van Siclen, *rw.ty* semble être le terme employé pour désigner un passage principal. Ces deux mentions de *rw.ty* sur l'axe sud permettent de supposer que les obélisques aient d'abord été dressés par Thoutmosis Iᵉʳ devant la grande porte que son prédécesseur Amenhotep Iᵉʳ plaça sur l'axe sud[24] (pl. 5e). Legrain décrivit ainsi la découverte de ses blocs (pl. 4e) :

---

20 Cette attribution a déjà été proposée par Legrain (Legrain (1904), pp. 22, 23) : 'Les deux obélisques tombés appartiennent, nous l'avons déjà dit, à Thoutmôsis III. Le pyramidion du plus grand est à l'extrémité sud de l'aile nord du IIIᵉ pylône, tout près de l'allée centrale. Il a été découvert et dégagé en 1898. L'identification et la classification des morceaux n'a pu encore être faite, mais l'énumération de métaux précieux qui se lit sur l'un d'eux nous permet d'espérer un texte intéressant. Un des tableaux qui décorent le haut de l'obélisque est surmonté du signe du ciel. Des trous, forés dans le champ de ce signe, semblent indiquer qu'une plaque de métal ou d'émail s'encastrait dans ce signe. Ces trous étaient remplis par des chevilles de bois que j'ai recueillies moi-même'.

21 Fouilles de Le Bohec dans la zone située entre les 4ᵉ et 5ᵉ pylônes.

22 Wallet-Lebrun (2010), p. 49 : 18/2B 'Cette dédicace nous apprend qu'Amenhotep Iᵉʳ éleva une porte d'une dizaine de mètres "à la sortie du temple" (*r rw.ty ḥw.t-nṯr*). C'est là une expression que l'on retrouvera pour les obélisques de Thoutmosis Iᵉʳ, dressés sur l'axe ouest-est du temple d'Amon. Mais, plus tard, l'expression servira à Amenhotep II pour désigner le VIIIᵉ pylône, devant lequel s'élève justement un colosse d'Amenhotep Iᵉʳ (PM II 176 [N]), autrement dit sur l'axe nord-sud'.

23 Traunecker (1982), pp. 203-205. L'auteur estime que ce texte appartient à la paire dressée devant le 4ᵉ pylône alors que l'autre paire serait celle du 7ᵉ pylône puisque le texte gravé est proche de celui de l'obélisque d'Istanbul.

24 Les photographies de Legrain montrent que la fouille de la 'cour de la cachette' n'a laissé aucun vestige archéologique au centre de la cour. Si des fosses de fondation existaient, elles ont désormais entièrement disparu.

'La porte d'Aménothès Ier fut abattue et enfouie de propos délibéré… Le plus haut de ses blocs est encore inférieur de 50 cm au niveau du sol de Thoutmosis III. La masse totale repose sur un sol damé, durci, composé de petits cailloux et d'une sorte d'escarbilles [morceaux de braises incomplètement brulées] que je n'ai pu exactement définir. Il était situé à 2,66 m au-dessous de celui de Thoutmosis III (+72.34). (Nous remarquerons que le grand pilier d'Ousirtasen était couché a une altitude à peu près semblable)… Nous pensons aussi que la porte d'Aménothès fut détruite sur place, c'est-à-dire qu'elle se trouvait non loin de là... Elle fut détruite par la base, car aucun des soubassements n'a été retrouvé. Aucune pierre ne porte de traces de feu. La chute eut lieu vers le sud, autant qu'il ressort de l'emplacement des blocs. Les plus méridionaux se trouvaient être ceux qui composaient le grand bas-relief [linteau] extérieur. Leur direction générale était est-ouest. À dix mètres de là, environ, nous rencontrâmes, à peu près rangés parallèlement, les blocs composant le bas-relief [linteau] intérieur. Par contre, les montants, assez bouleversés, allaient plutôt selon une ligne nord-sud'.[25]

'Les blocs composant la porte d'Aménothès Ier jonchaient un sol durci composé de terre damée et d'une escarbille noirâtre dont nous n'avons pu déterminer la nature. C'est là, sous les pierres écroulées, que nous avons rencontré un dépôt fortuit composé de faïences diverses et d'un grand fossile calcaire.
- A. La pièce la plus importante est une grande faïence découpée, montrant le roi passant vers la gauche, coiffé du pschent et présentant le pain. Elle est d'un fort bon style et ne mesure pas moins de 35 cm. Elle était brisée en trois morceaux, la face contre terre. La couleur primitive était verte ; une mince feuille d'or recouvrait cette représentation.
- B. Devant elle, recevant l'offrande, se trouvait une image de *Minou*. Nous n'en avons retrouvé qu'une main et le haut du fouet.
- C. Nous trouvâmes encore : un fragment de bâton en forme de serpent sur lequel se lisait distinctement le cartouche Djéserkarê au moment de la découverte ; les couleurs se sont affaiblies depuis ; une tête de sceptre *Ouas*, des fragments d'un grand signe *ankh* et enfin les morceaux d'un de ces cercles de faïence imitant les *outen*, comme dans le tombeau de Mahirpra'.[26]

Il est désormais possible de restituer l'emplacement de cette grande porte sud d'Amenhotep Ier presque à l'endroit même où ses blocs ont été découverts dans la 'cour de la cachette'. En effet, des photos anciennes[27] montrent un mur en brique orienté est-ouest, dont six assises ont été mises au jour et dessinées par Legrain, juste au nord des blocs étalés de la porte d'Amenhotep Ier (pls. 2, 3, 4a+b+c+d+f). Voici la description qu'il en fit :

'II y a une dépendance ou seconde favissa de l'autre côté de la route qui va de l'obélisque de Thoutmosis Ier au 7e pylône. Elle est parfaitement déterminée et présente la coupe suivante :
- A. Dallage de grès et de calcaire amorphe.
- B. Six rangs de briques.
- C. Couche de sable.
- D. Remblai composé d'environ 75% sable, 20% de tîn, 5% brique.

Le tout s'arrête, brusquement, au sud devant un terrain plus ancien taillé à pic F et un autre E dans lequel se trouvent des pierres du monument d'Amenothès Ier d'enfouissement préatonien'.[28]

Il paraît logique d'identifier ces six assises en brique aux fondations de l'imposante clôture en brique crue dans laquelle cette porte monumentale devait être encastrée.

---

25 Legrain (1903), pp. 16-17.
26 Legrain (1903), p. 20.
27 Grimal et Larché (2003), p. 24. J'ai découvert ce lot de plaques photographiques au cours du déménagement du laboratoire photographique égyptien du CFEETK. Ces photographies ont probablement été exécutées par Abou al-Naga Abdallah au cours des fouilles de Sh. Adam et F. al-Shaboury dans la 'cour de la cachette' (Adam et al-Shaboury (1959)).
28 Azim et Réveillac (2004), p. 280.

Cette porte a la particularité d'avoir deux vantaux comme l'indique la surface non décorée des tableaux de l'embrasure (pls. 2, 3). Lorsque cette porte fut démantelée par Maâtkarê,[29] la reine aurait alors mis à terre les deux obélisques de Thoutmosis Ier qui étaient bien placés devant la *rw.ty* du temple, la porte sud d'Amenhotep Ier. Puis, Thoutmosis III les fit ériger à nouveau, en même temps que ses propres obélisques, sur les longues fondations communes qu'il installa entre le 4e pylône et les obélisques de Maâtkarê-Thoutmosis II. Bien qu'aucune inscription n'ait été conservée sur le 4e pylône, ce dernier fut dès lors assimilé à la *rw.ty* en raison du texte la mentionnant sur la face ouest de l'obélisque sud de Thoutmosis Ier (pls. 6, 7). Ainsi la grande porte sud d'Amenhotep Ier et sa nature de *rw.ty* furent oubliées jusqu'aux fouilles de Legrain. Cette grande porte a peut-être remplacé une porte d'Ahmosis comme semblerait l'indiquer le linteau au nom de ce roi remployé dans le tableau oriental de la grande porte d'Amenhotep Ier (pl. 3b). Cette porte d'Ahmosis aurait probablement remplacé une porte primitive de Sésostris Ier, probablement l'ancêtre du 7e pylône, dont le tableau ouest était décoré d'une scène de montée vers le temple d'Amon avec une niche creusée dans le parement[30] (pl. 1).

Intervention de Maâtkarê au début de son règne

Après son couronnement, Maâtkarê fit construire à l'ouest du 4e pylône, de part et d'autre de l'axe, deux fondations écartées[31] sur lesquelles allaient reposer les deux obélisques au nom de Maâtkarê-Thoutmosis II[32], dont les dimensions sont semblables à celles de l'obélisque sud de Thoutmosis Ier (pls. 8, 10, 11, 19, 34).

Intervention de Maâtkarê vers l'an 16

Autour de l'an 16, Maâtkarê fit dresser une nouvelle paire d'obélisques sur les fondations à trois assises qu'elle fit construire devant le 5e pylône[33] (pl. 12). Ces obélisques furent ensuite rapidement chemisés par ses soins (pl. 12).

Deux paires d'obélisques sont représentées sur le mur du fond du portique sud de la première terrasse[34] du Djeser-djeserou. On les voit d'abord couchés sur une grande barge où la longueur

---

29 La fouille de la 'cour de la cachette' n'a malheureusement laissé aucune trace d'éventuelles fosses de fondation d'obélisques ni de la porte d'Amenhotep Ier.

30 Van Siclen propose de placer la grande porte d'Amenhotep Ier à l'aplomb d'une large fondation en brique crue qu'il a identifié entre les 8e et 9e pylônes. Un dallage de pierre venant du sud s'y arrêtait et le chemin vers le nord y changeait légèrement de direction. Cependant, il n'a pas repéré de fondations d'obélisques alors que onze très longs blocs forment curieusement la base de la clôture orientale liant les 8e et 9e pylônes. Ces blocs pourraient-ils provenir de ces fondations ?

31 Celles actuellement enfouies sous le 3e pylône.

32 Dans la publication électronique de la chapelle Rouge (Burgos et Larché (2015), pp. 457-462), la diminution des dimensions de ces obélisques de Maâtkarê-Thoutmosis II m'avait déjà permis de reconsidérer mon hypothèse de 2007 (Larché (2007), pp. 492-493, pls. LXII-LXVIII) qui plaçait par erreur les obélisques de Thoutmosis III sur ces fondations sous le 3e pylône. L. Gabolde avait déjà fait l'hypothèse de placer sur ces fondations les obélisques de Maâtkarê-Thoutmosis II (Gabolde (1993), pp. 1-100) bien que sa surface restituée de la base du fût était incompatible avec le tracé visible sur les deux fondations.

33 Est-ce à l'emplacement où son père Thoutmosis Ier avait voulu dresser ses obélisques ? Larché (2007), p. 464 : 'Sa majesté (Hatshepsout) a fait en sorte que le nom de son père (Thoutmosis Ier) soit établi sur ce monument durable, <et> qu'ainsi hommage soit rendu au roi de Haute et Basse-Égypte, maître du double pays, Âakheperkarê, par la majesté de ce dieu auguste, ainsi deux grands obélisques ont été érigés par sa majesté (Hatshepsout) pour la première fois. Voilà ce qui fut dit par le maître des dieux : n'est-ce pas ton père, le roi de Haute et Basse Égypte, Âakheperkarê qui a décrété l'installation d'obélisques <ici>, ce que ta majesté (Hatshepsout) aura <effectivement> refait, étant douée de vie ?' ; *Urk*. IV, 357, 2-9 ; Carlotti et Gabolde (2003), p. 275; Wallet-Lebrun (2010), p. 68, texte 18/5 A : 'Hatshepsout… Sa Majesté a fait inscrire le nom de son père sur ce monument durable, hommage étant ainsi rendu à Thoutmosis Ier par la Majesté de ce dieu (1) lors de l'érection par Sa Majesté (1) de sa première paire de magnifiques obélisques. En effet, le maître des dieux avait dit : 'C'est ton père Thoutmosis Ier qui a fait des obélisques un canon (2). Aussi Ta Majesté se devra-t-elle d'exécuter un monument de ce type. Puisses-tu vivre à jamais !'.

34 Naville (1907), pl. CLVI : le dessin publié étant plus étiré que la scène aujourd'hui visible, il ne peut résulter que du mauvais restituée de l'obélisque de droite est bien inférieure à celle de celui de gauche. Dans l'hypothèse où cette différence de longueur est l'image de la réalité, il est possible que le plus petit des obélisques représente la paire au nom de Maâtkarê-Thoutmosis II et le plus grand la paire de la *Ouadjyt*. Puis, à la suite de cette scène de navigation, Maâtkarê consacre quatre obélisques à Amon. Les fûts de ces derniers sont gravés d'une colonne de texte centrale et une scène décore leur pyramidion tel qu'on le voit encore sur les fragments conservés de ces deux paires d'obélisques de la reine.

Première intervention de Thoutmosis III

Thoutmosis III fit construire, dans la grande cour consacrée par Maâtkarê à Thoutmosis II, à l'est des obélisques de Maâtkarê-Thoutmosis II, deux nouvelles longues fondations dont chacune des quatre extrémités fut coiffée d'un gradin en grès supportant une base en granite (pls. 13, 19). Il fit redresser sur leur extrémité orientale les obélisques de Thoutmosis Ier (pls. 6, 7) et il installa sur leur extrémité ouest une nouvelle paire d'obélisques à son nom (pls. 14, 15). Les nouvelles fondations étant moins écartées que celles des obélisques de Maâtkarê-Thoutmosis II, ces derniers ne cachaient pas le parement ouest des obélisques de Thoutmosis III. L'explication par L. Gabolde[35] de l'ordre de construction des fondations des obélisques repose davantage sur la facilité à manier les blocs virtuellement que sur la réalité du terrain et sur les poids à prendre en considération pour leur manipulation. En effet, il semble avoir oublié que les énormes blocs de ces fondations sont imbriqués les uns dans les autres comme les pièces d'un leggo et que, par conséquent, leur ordre de pose est imposé par cette imbrication[36] ; qu'il aurait été très imprudent de creuser une profonde fosse de fondation (hauteur : 4 m) entre des obélisques déjà en place, comme il en fait l'hypothèse hasardeuse pour installer les obélisques de Thoutmosis III entre les obélisques de Thoutmosis Ier, à l'est, et ceux de Maâtkarê-Thoutmosis II, à l'ouest (pls. 19-33).

Seconde intervention de Thoutmosis III

Au moment de la 'soi-disant proscription', Thoutmosis III fit effacer le nom de la reine sur la paire d'obélisques aux noms de Maâtkarê-Thoutmosis II pour le remplacer par celui de Thoutmosis II, alors que le nom original de ce dernier est resté intact (pls. 10, 11). Sur les obélisques orientaux de la reine, il fit remplacer chaque représentation de Maâtkarê par une table d'offrande. Cependant, il ne put effectuer ce martelage sur les obélisques du chemisage, leur moitié inférieure étant entièrement cachée par ce dernier, et leur moitié supérieure l'étant partiellement par la couverture en construction de la salle à colonnes papyriformes appelée *Ouadjyt*. Le pyramidion et les cinq registres supérieurs sont restés visibles au-dessus de cette couverture (pl. 12). Sur les quatre faces de l'obélisque sud, le nom et la figure de la reine ont été martelés sur les 3e et 4e registres à partir du pyramidion. Puis ils ont été restaurés au nom de Thoutmosis III sur deux faces, alors que les deux autres l'ont été plus tard à celui de Séthi Ier. Sur l'obélisque nord, seul le 5e registre montre un remaniement puisque, le nom d'Amon ayant été effacé dans le cartouche d'Hatshepsout-Khenemetamon, ce

montage de deux fac-similés préparatoires puisqu'il semble bien improbable que les blocs aient été déplacés au cours d'une restauration, ce qu'une photographie ancienne du parement permettrait de vérifier. La longueur de l'obélisque de droite est mesurable entre sa pointe et son lit de pose bien représenté par une ligne verticale. Si la pointe et la majeure partie de l'obélisque de gauche sont bien conservées, son lit de pose a malheureusement disparu dans la cassure. Néanmoins, il est possible de le restituer grâce à l'espacement régulier des cordes qui arriment chaque monolithe au bateau. La longueur ainsi restituée de l'obélisque de droite est bien inférieure à celle de celui de gauche, ce qui est un indice supplémentaire pour l'identifier à la paire au nom de Maâtkarê-Thoutmosis II et non pas à celle de Thoutmosis Ier comme j'en avais fait précédemment l'hypothèse (Larché (2007), p. 474).

35 Gabolde (2012), p. 468, fig. 3-8.

36 Larché (2007), p. 474 ; Larché (2010), pp. 297-326 ; Letellier et Larché (2014), pp. 20-23.

cartouche a été regravé au nom de Séthi I[er]. Une seule exception apparaît au 6[e] registre de l'obélisque nord (à partir du haut du parement ouest) sur lequel le torse de la reine et son cartouche ont été martelés, probablement parce que la couverture de la *Ouadjyt* n'était pas encore achevée à cet endroit. Si le martelage a bien été effectué sur la partie de l'obélisque sud dépassant le chemisage, l'obélisque nord semble y avoir échappé en grande partie. En revanche, Akhénaton fit soigneusement effacer le nom et la représentation d'Amon sur la partie visible des deux obélisques.

La chapelle d'Amenhotep II entre les obélisques de Thoutmosis I[er]

Cette chapelle en calcite a été reconstruite en 2005, entre les copies des deux obélisques de Thoutmosis I[er], à l'entrée du musée en plein air de Karnak. Afin de réaliser cette anastylose, une étude préalable de l'ensemble des fragments a été réalisée et publiée d'abord en français en 2007, puis en anglais en 2010.[37]

L'encastrement de la chapelle d'Amenhotep II entre les obélisques de Thoutmosis I[er] (pls. 17, 18) a été remis en cause dans un article écrit en 2012 par L. Gabolde.[38] La suite va montrer que cette contestation repose sur un plan malheureusement déformé et par conséquent inexact du parvis du 4[e] pylône.[39] En effet, ce plan[40] n'est pas superposable au plan topographique du temple de Karnak (pl. 19). Si les proportions sont bien respectées dans le sens nord-sud, elles sont comprimées de presque 10% dans le sens est-ouest, ce qui complique l'encastrement de la chapelle dont les dimensions sont, elles, incompressibles (et à peu près justes sur ce plan) ! Un détail légèrement agrandi sur une seconde figure de l'article[41] représente l'espace coté entre les deux bases sud. Comme cette figure n'a pas d'échelle, je l'ai superposée au plan topographique. Mais, contrairement au dessin précédent,[42] les bases des obélisques ont ici les bonnes proportions, alors que la chapelle a été représentée beaucoup plus longue que sa reconstruction. Ainsi, sur le plan, la chapelle a des dimensions correctes, mais les bases des obélisques sont trop rapprochées, tandis que sur la figure, les bases sont justement positionnées, mais la chapelle est beaucoup trop longue. De telles distorsions de la réalité ont malheureusement induit en erreur l'auteur de ces illustrations.

D'autre part, les mesures utilisées dans cet article reposent sur la base d'obélisque adossée au sud de la porte du 3[e] pylône (pl. 19). Or, l'emplacement de cette base soulève une interrogation puisqu'elle a été déplacée par Pillet pour permettre le transport du plafond de la chapelle d'Amenhotep II, qui était remployé dans le môle sud du 3[e] pylône.[43] Aujourd'hui, la face orientale de cette base sud n'est pas parallèle à la face ouest de la base sud de Thoutmosis I[er] (écart entre les bases de 2,07 m au nord et de 2,17 m au sud), alors que sa face ouest n'est pas alignée avec celle de la base symétrique de Thoutmosis III au nord. Ces deux anomalies laissent un doute sur le fait que Pillet ait remis cette base sud exactement à sa place d'origine après le passage du plafond. Ayant moi-même fait déplacer d'imposants monolithes, je reconnais la difficulté d'une telle manœuvre aussi bien aujourd'hui qu'avec les moyens de l'époque. À l'origine, cette base était probablement installée légèrement plus à l'ouest de façon à ce que les faces ouest des deux bases de Thoutmosis III soient bien alignées (pl. 19).

Cependant, même si cette base sud était aujourd'hui à sa place primitive, rien n'empêcherait le fond de la chapelle d'Amenhotep II de s'y encastrer, comme s'encastre son côté sud dans la base sud de

37 Larché (2007), p. 474 ; Larché (2010), p. 297-326 ; Letellier et Larché (2014), pp. 23-25.
38 Gabolde (2012).
39 Gabolde (2012), p. 474, figs. 12, 13.
40 Gabolde (2012), p. 474, fig. 12.
41 Gabolde (2012), p. 474, fig. 13.
42 Gabolde (2012), p. 474, fig. 12.
43 Photographies du CFEETK B095-01+06+08.

Thoutmosis Ier. Malheureusement, l'angle sud-ouest de la chapelle n'étant pas conservé au niveau de la base sud en granite de Thoutmosis III, on ne peut plus le constater précisément (pls. 19-33).

Le problème de place soulevé par L. Gabolde concerne l'angle nord-ouest de la chapelle où un petit bloc muni d'un tore a été encastré dans la maçonnerie (pl. 29). Ce bloc n'ayant aucun lien structurel avec ceux du parement interne de la chapelle, sa reconstruction à ce niveau n'est qu'hypothétique et il aurait pu être placé plus haut, ce qui aurait mis la ligne de sol conservée à un niveau supérieur à celle du côté sud. Ces différences de niveau de ligne de sol dans le même monument sont très courantes.

Enfin, les mesures de L. Gabolde ne possèdent pas la précision requise puisqu'elles reposent sur deux bases dont les dimensions sont inconnues (pl. 19) :

- La base nord de Thoutmosis Ier ayant disparu, on ignore son emplacement exact. Avait-elle les mêmes dimensions que la base sud ? était-elle le symétrique parfait de la base sud ? Son parement ouest était-il aligné avec le parement ouest de la base sud ?

- Le parement oriental de la base nord appuyée au 3e pylône étant complètement détruit, on ne peut que le restituer hypothétiquement dans l'alignement de la base symétrique sud. Ce parement oriental ne peut dépasser vers l'est l'aplomb de la découpe du socle en grès sur lequel la base repose (pl. 13). En effet, il aurait été impossible de faire cette découpe sous la base. Le parement de la base est soit à l'aplomb de cette découpe, soit plus à l'ouest.

Enfin les photographies de la fouille de la 'cour de la cachette'[44] ne révèlent aucune trace des fondations du soi-disant mur fantôme proposé par J.-Fr. Carlotti[45] pour positionner la chapelle d'Amenhotep II dans cette cour (pl. 4). Au contraire, les découpes de fondation de la chapelle sont bien réelles dans l'arase de fondation des obélisques de l'axe ouest-est, devant le 4e pylône, alors que rien n'a été découvert dans la 'cour de la cachette'. En ce qui concerne les lignes talutées incisées sur le parement ouest du mur oriental de la cour, lignes qui guident l'hypothèse de J.-Fr. Carlotti, il est plus sensé d'y voir le contour d'un naos appliqué contre le parement de façon à abriter le sphinx qui s'y trouvait[46] (pl. 36).

Pour conclure, cette remise en cause de mes travaux est la conséquence d'un raisonnement que l'on peut dire circulaire, car il s'autojustifie et ne prend pied à aucun moment dans l'ancrage d'un quelconque réel archéologique.

Bibliography

Adam, Sh. et al-Shaboury, F. (1959), 'Report on the Work of Karnak during the Seasons 1954-55 and 1955-56', *ASAE* 56, pp. 35-52.

Azim, M. et Réveillac, G. (2004), *Karnak dans l'objectif de Georges Legrain. Catalogue raisonné des archives photographiques du premier directeur des travaux de Karnak de 1895 à 1917*, Paris : CNRS éditions.

Burgos, Fr. et Larché, Fr. (2008), *La chapelle Rouge. Le sanctuaire de barque d'Hatshepsout,* vol. 2, Paris : ERC.

Burgos, Fr. et Larché, Fr. (2015), *Le sanctuaire de barque d'Hatshepsout,* vol. 2, Paris : Soleb éditions.Carlotti, J.-Fr. et Gabolde, L. (2003), 'Nouvelles données sur la Ouadjyt', *Karnak* 11, pp. 255-338.

Carlotti, J.-Fr. (2008), 'Le mur fantôme de la "cour de la cachette" du temple d'Amon-Rê à Karnak', dans L. Gabolde (éd.), *Hommages à Jean-Claude Goyon*, *BdE* 143, Le Caire : IFAO, pp. 55-66.

Gabolde, L. (1987), 'À propos de deux obélisques de Thoutmosis II à Karnak, dédiés à son père Thoutmosis I et érigés sous le règne d'Hatshepsout-pharaon à l'ouest du IVe pylône', *Karnak* 8, pp. 143-158.

44 CFEETK 94507.

45 Carlotti (2008), pp. 55-66, p. 65, fig. 4.

46 Larché (2010), p. 326, fig. 12.

Gabolde, L. (1993), 'La "cour de fêtes" de Thoutmosis II à Karnak', *Karnak* 9, pp. 1-100.

Gabolde, L. (2003), 'Compléments sur les obélisques et la "Cour de Fêtes" de Thoutmosis II à Karnak', *Karnak* 11, pp. 417-469.

Gabolde, L. (2012), 'Le parvis et la porte du IVe pylône à Karnak. Considérations sur une chapelle et des obélisques', dans Chr. Zivie-Coche et Y. Guermeur (éds.), *Parcourir l'éternité. Hommages à Jean Yoyotte*, t. 1, *BEHE* 156, Turnhout : Brepols, pp. 459-481.

Grimal, N. et Larché, Fr. (2003), 'Karnak, 1994-1997', *Karnak* 11, pp. 7-64.

Larché, Fr. (2007), 'Nouvelles observations sur les monuments du Moyen et du Nouvel Empire dans la zone centrale du temple d'Amon à Karnak', *Karnak* 12, pp. 407-592.

Larché, Fr. (2010), 'The chapel of Amenhotep II embedded between the obelisks of Tuthmosis I', *Karnak* 13, pp. 297-326.

Lauffray, J. (1980), 'Les travaux du Centre Franco-Egyptien d'Etude des Temples de Karnak de 1972 à 1977', *Karnak* 6, p. 1-65.

Legrain, G (1903), 'Second rapport sur les travaux exécutés à Karnak du 31 octobre 1901 au 15 mai 1902', *ASAE* 4, 1903, pp. 1-40.

Legrain, G. (1904), 'Rapport sur les travaux exécutés à Karnak du 28 septembre 1903 au 6 juillet 1904', *ASAE* 5, pp. 265-280.

Letellier, B. et Larché, Fr. (2014), *La cour à portique de Thoutmosis IV*, Paris : Soleb éditions.

Masson, A. et Millet, M. (2007), 'Sondage sur le parvis nord du 4e pylône', *Karnak* 12, pp. 659-679.

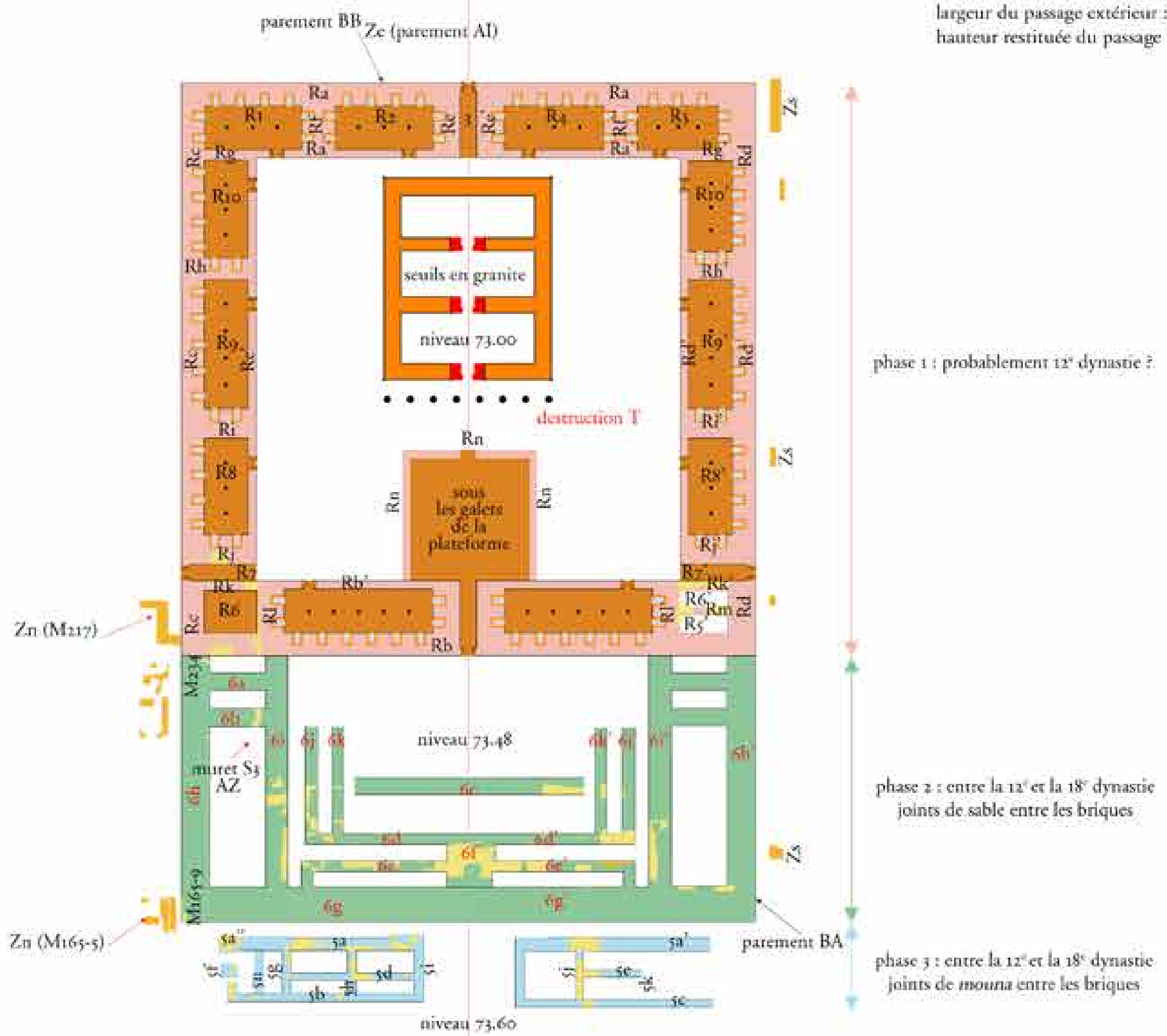
Naville, E. (1907), *Deir el-Bahari*, vol. 6, Londres : EEF.

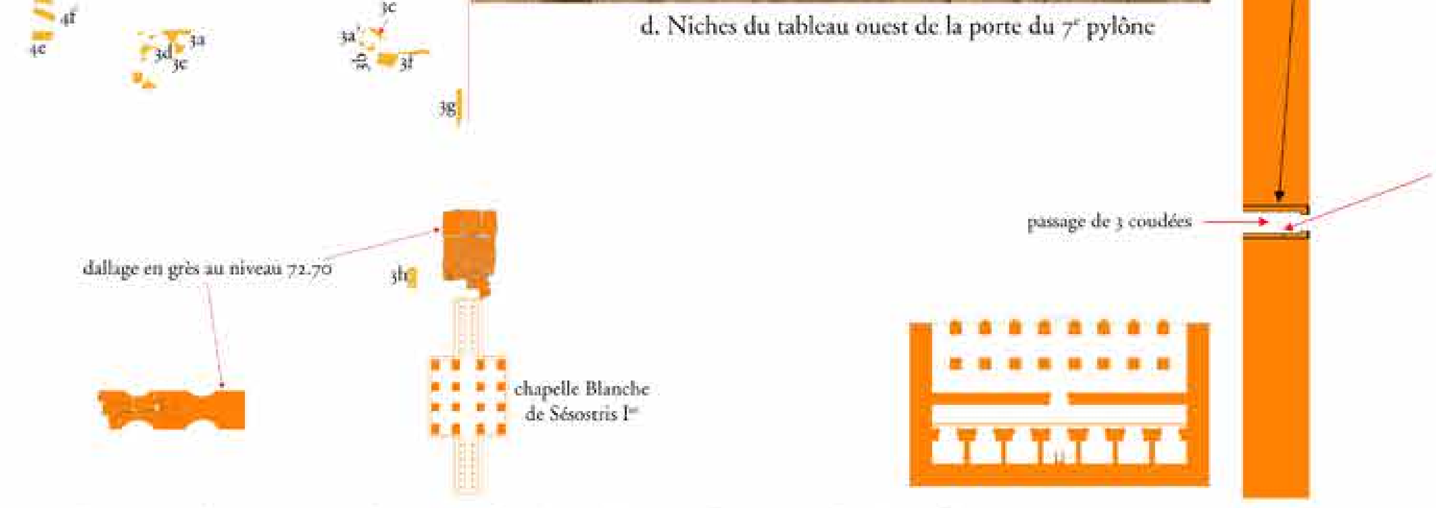
Sauneron, S. et Vérité, J. (1969), 'Fouilles dans la zone axiale du 3e pylône à Karnak', *Kémi* 19, pp. 249-276.

Traunecker, Cl. (1982), 'Estimation des dimensions de l'obélisque ouest du VIIe pylône', *Karnak* 7, pp. 203-208.

Wallet-Lebrun, Chr. (2010), *Le grand livre de pierre. Les textes de construction à Karnak*, Paris : AIBL-Soleb éditions.

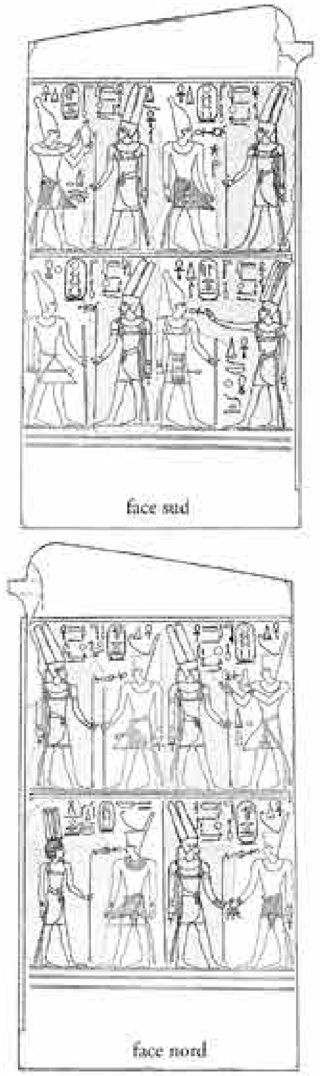
Pl. 1. Hypothèse de restitution de la porte sud de Sésostris I[er].

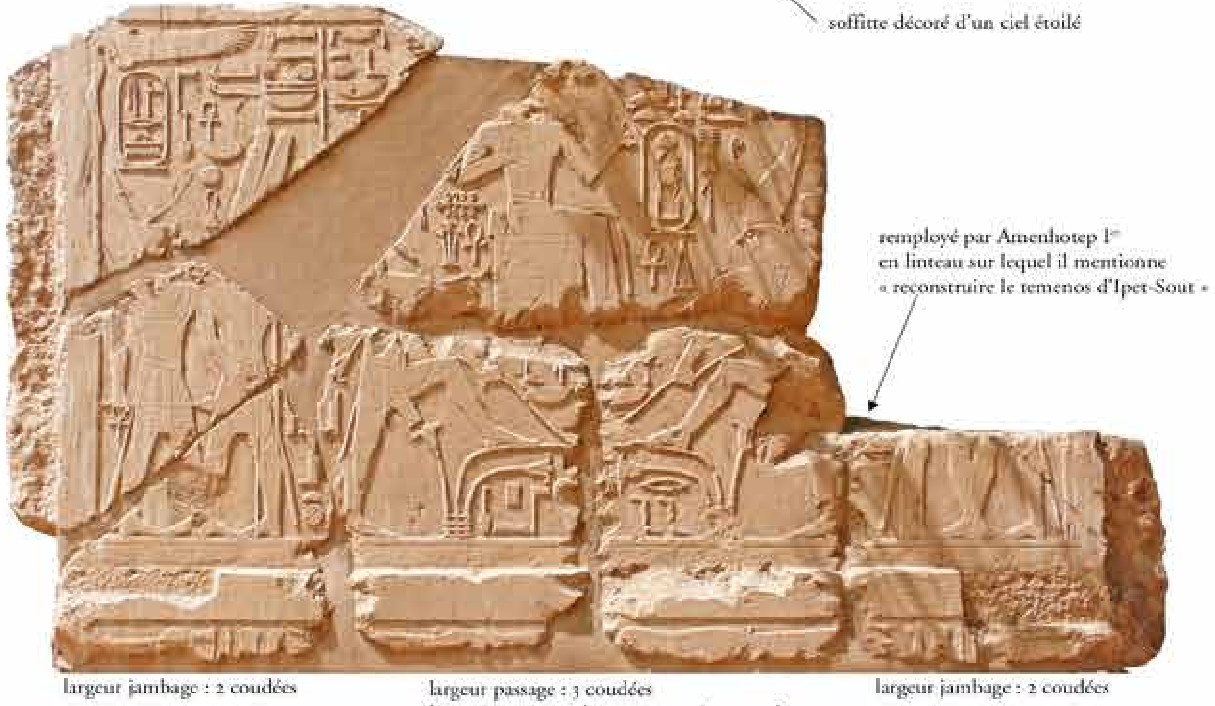




a. Restitution des structures en brique crue du Moyen Empire à l'avènement du Nouvel Empire

b. Linteau intérieur en calcaire dur
face nord ?
(*Karnak 8*, p. 302-305, 319, pl. 6 ; cfeetk 25835)
largeur du passage intérieur : 187,6 cm
largeur du passage extérieur : 3 coudées
hauteur restituée du passage : 9 à 10 coudées

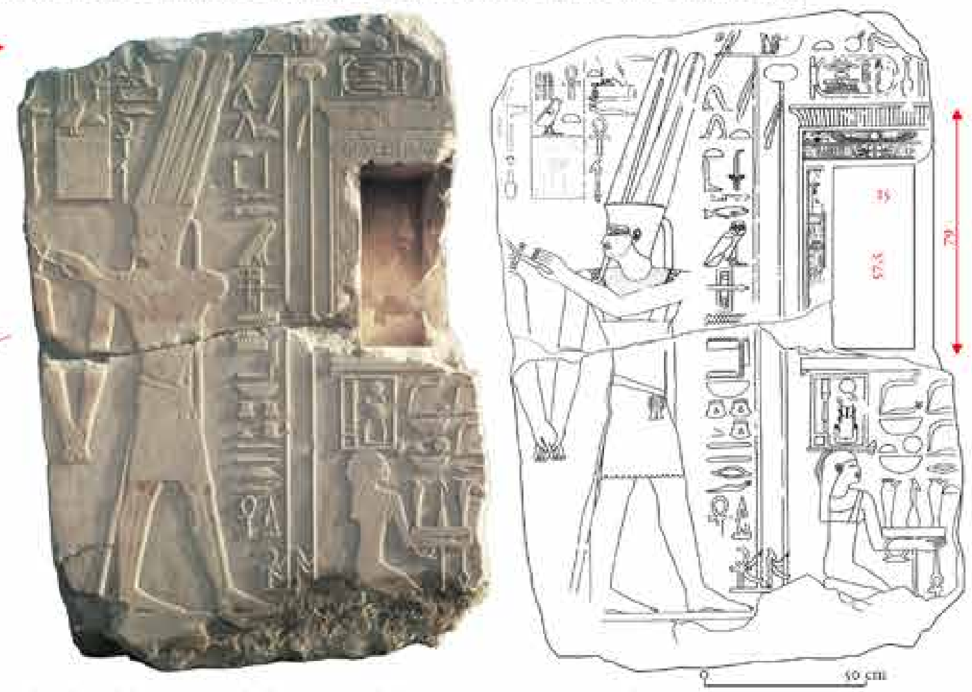




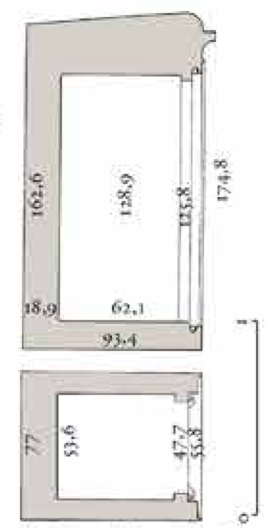
c. Dessus-de-porte en calcaire, encastré dans un mur en brique (face sud ?)
(Chevrier, *ASAE* 53, p. 41, cfeetk 41508/13, 44371)

Trouvés dans la cour de la cachette, les 2 linteaux couvraient un passage large de 3 coudées, ce qui laisse supposer une seule porte : le linteau intérieur, gravé en creux ferait face au nord alors que l'extérieur, gravé en relief, ferait face au sud tout en étant protégé par un dais (h : 12 ou 13 coudées) supporté par 2 colonnes. La décoration des 2 linteaux est couronnée d'un disque solaire ailé.

d. Niches du tableau ouest de la porte du 7e pylône



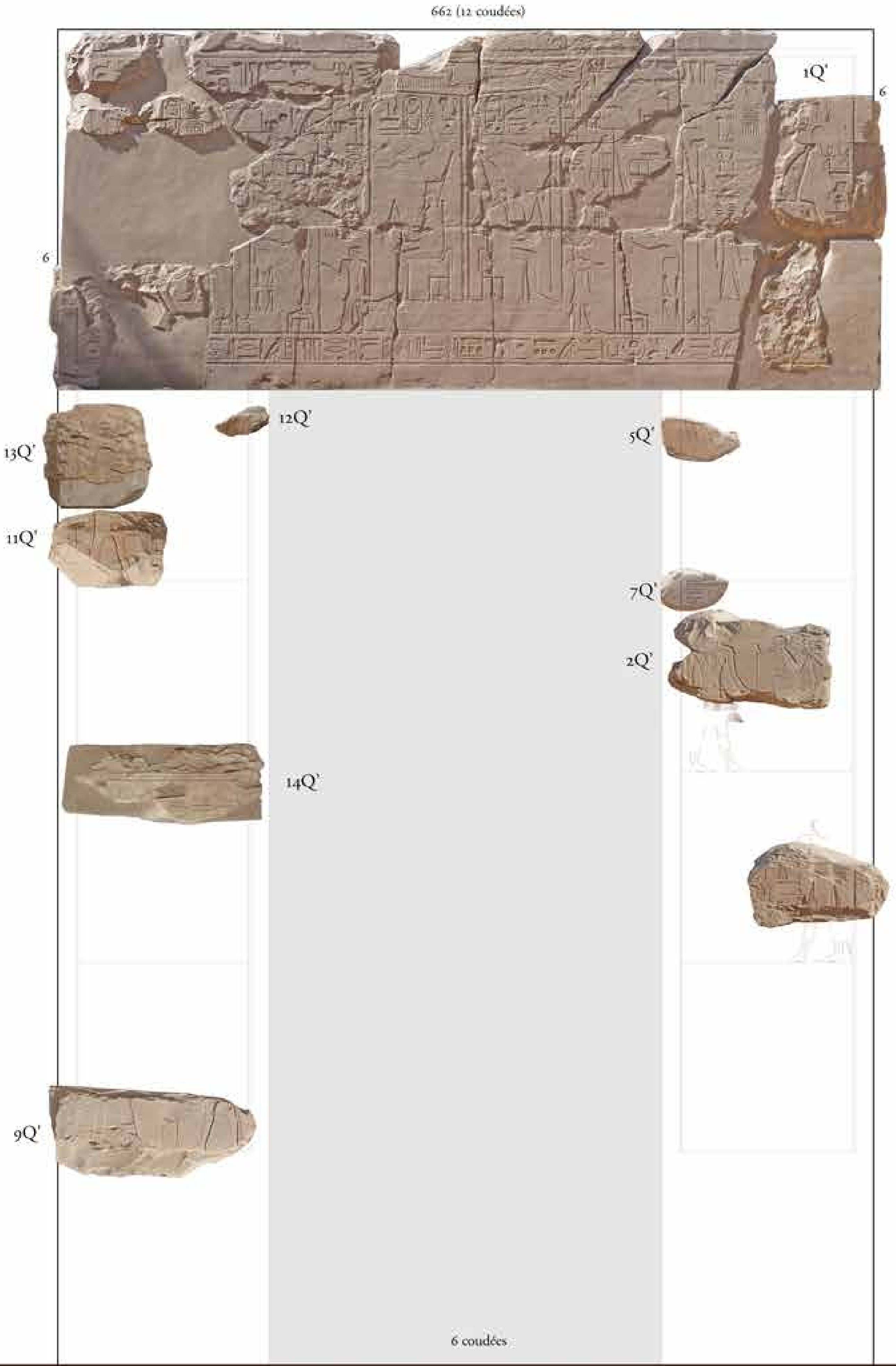
le naos en diorite de Sésostris Ier a une façade identique mais fait le double de la niche

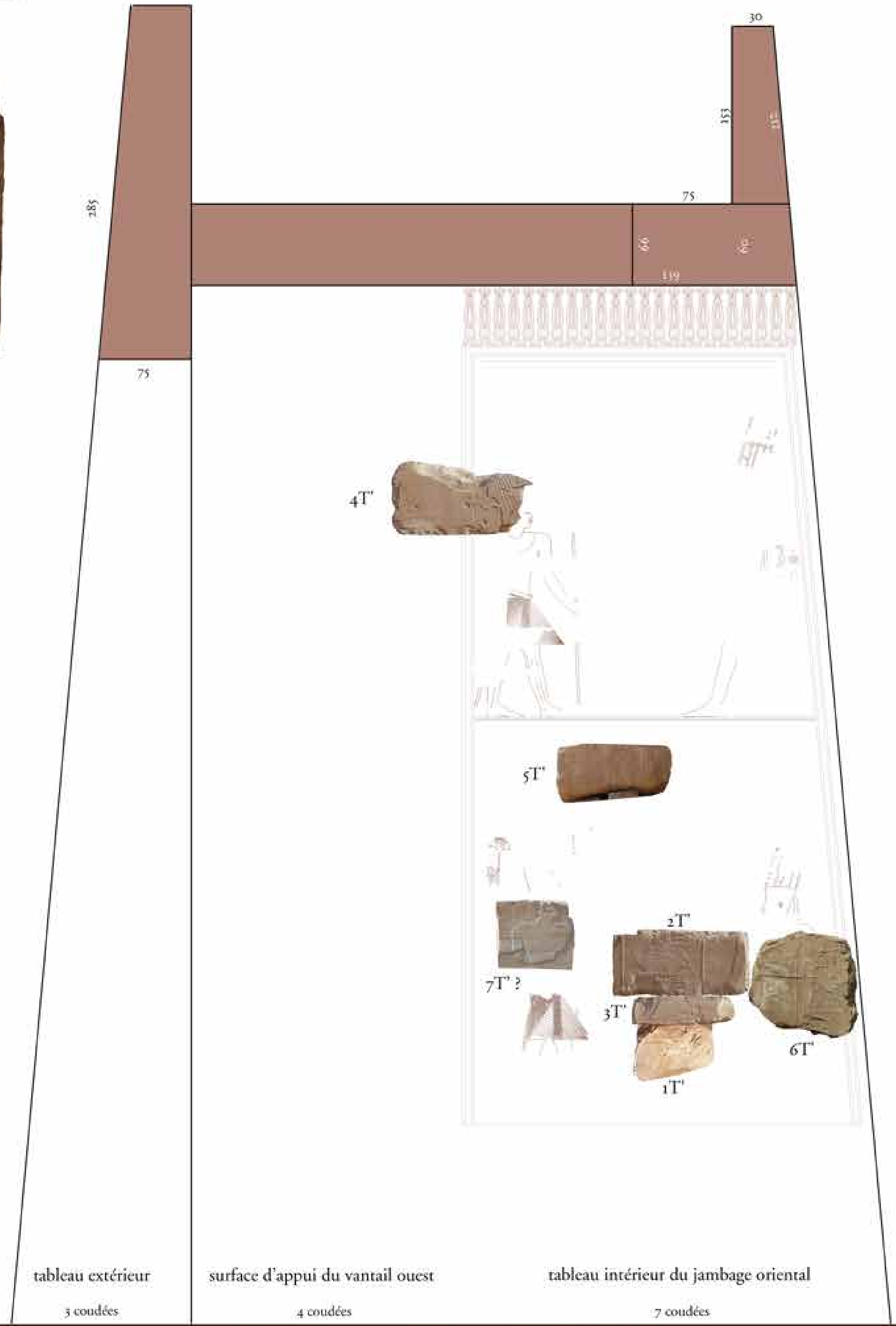


e. Niche du tableau ouest de la porte sud de Sésostris Ier, ancêtre du 7e pylône (cfeetk 25870, 30036)

f. Naos en diorite de Sésostris Ier enfoui sous le monastère dans la moitié orientale de la cour du 8e pylône

Pl. 2a. La grande porte sud d'Amenhotep Iᵉʳ.



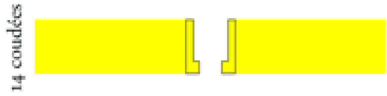


a. Face sud de la porte sud d'Amenhotep Iᵉʳ

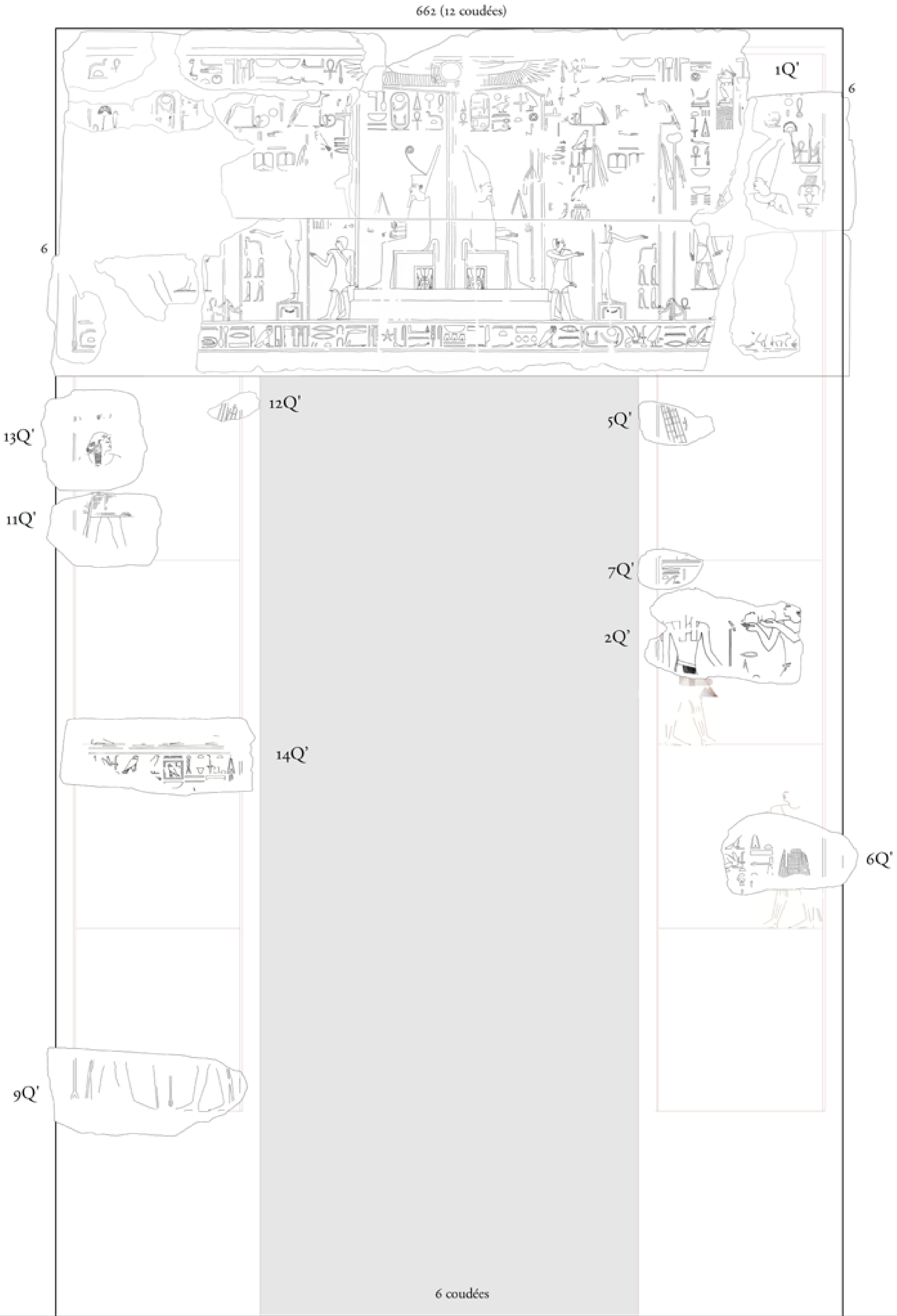
0 — 1 m

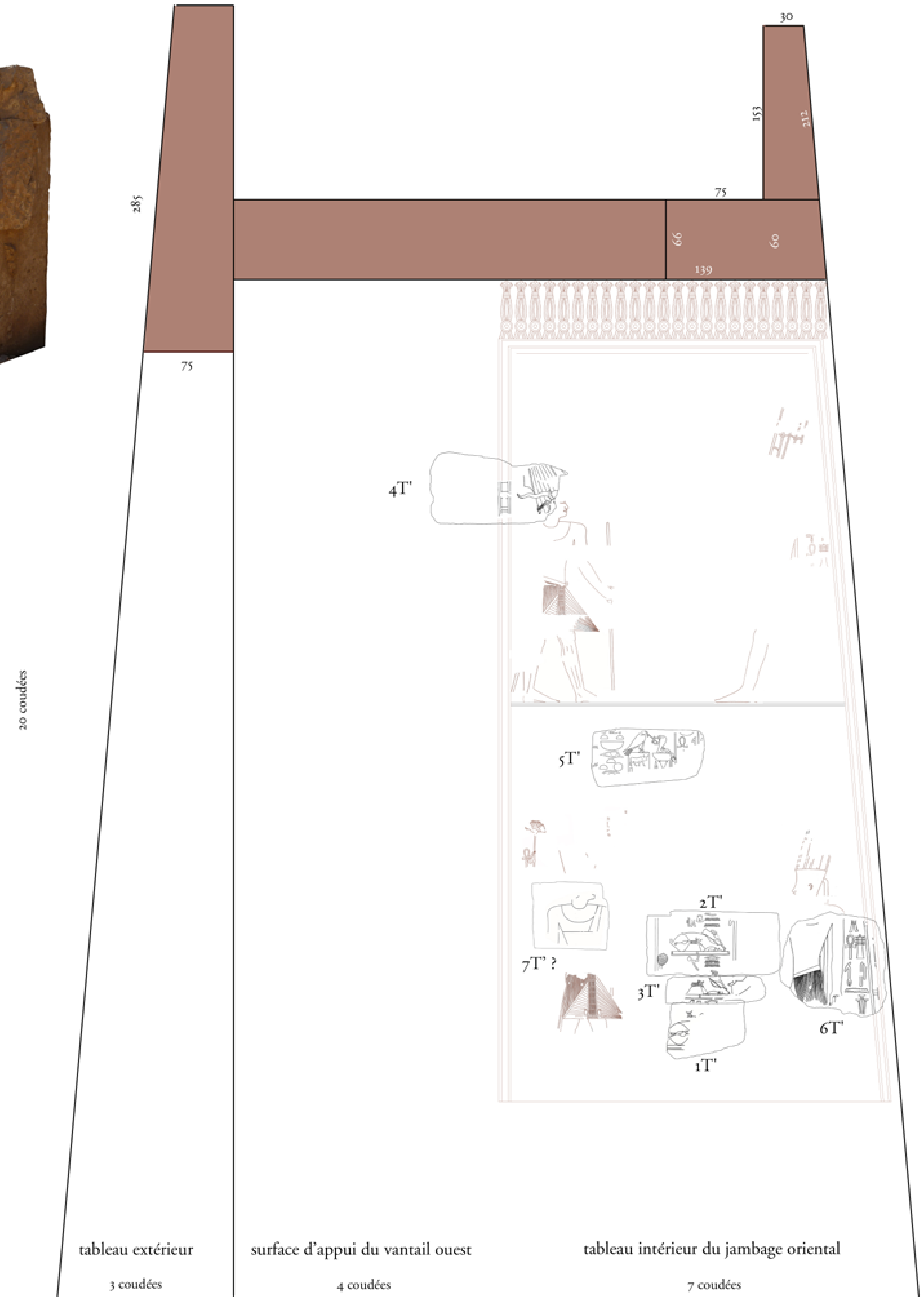
b. Tableau ouest de la porte sud d'Amenhotep Iᵉʳ

Pl. 2b. La grande porte sud d'Amenhotep Ier.



porte sud d'Amenhotep Ier
placée dans la cour de la cachette



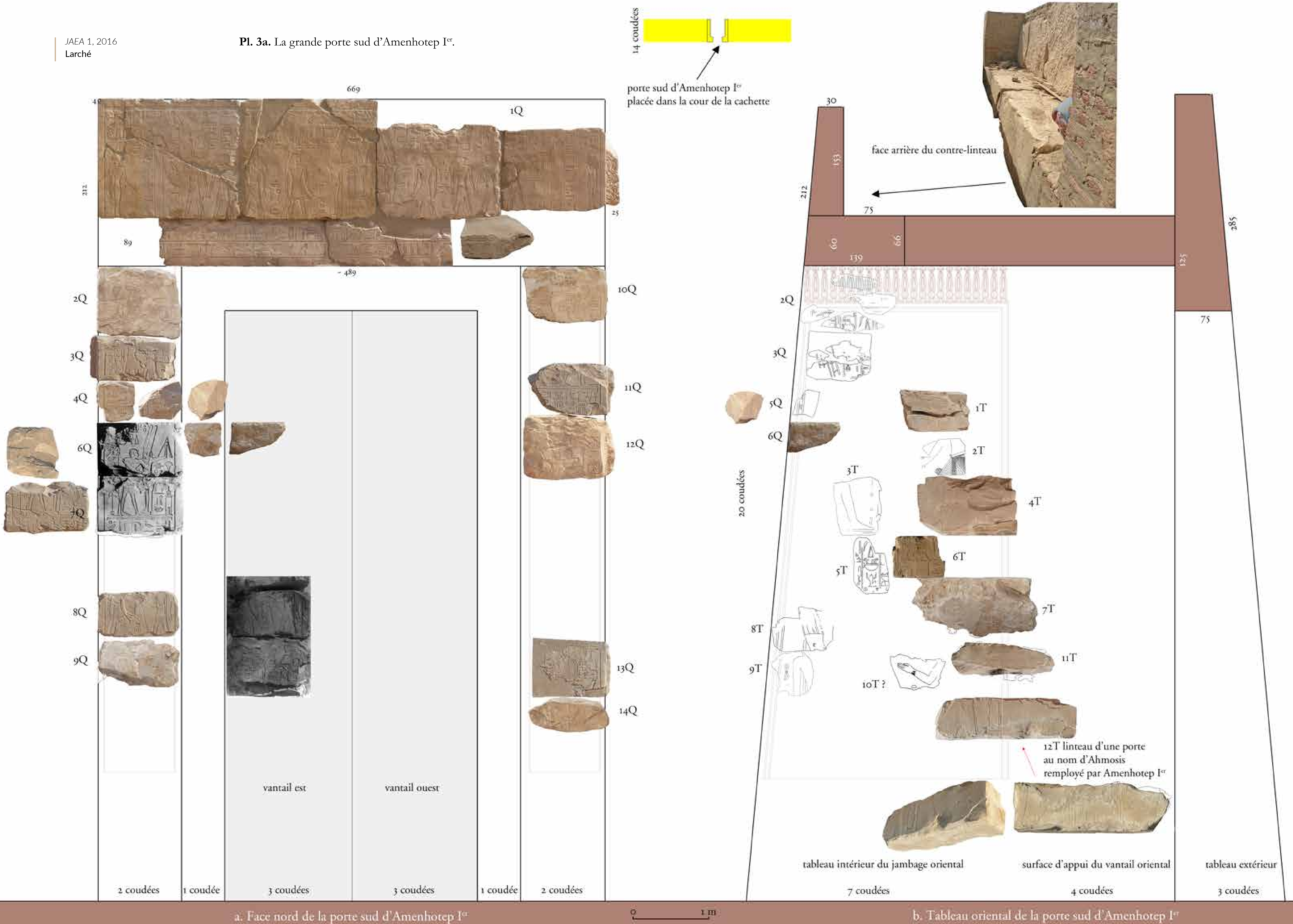


a. Face sud de la porte sud d'Amenhotep Ier

0 1 m

b. Tableau ouest de la porte sud d'Amenhotep Ier

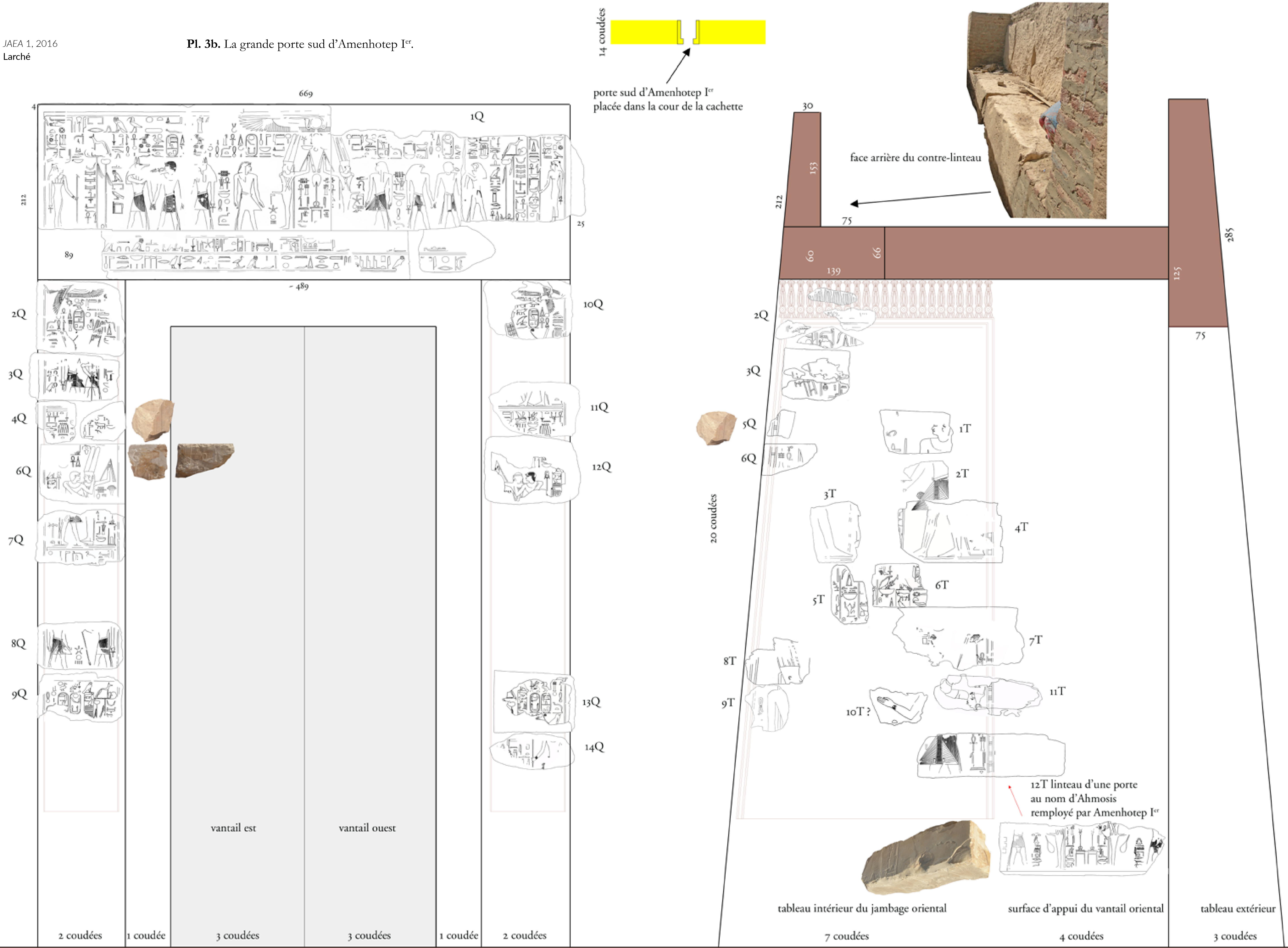
Pl. 3a. La grande porte sud d'Amenhotep Ier.



a. Face nord de la porte sud d'Amenhotep Ier

b. Tableau oriental de la porte sud d'Amenhotep Ier

Pl. 3b. La grande porte sud d'Amenhotep Ier.

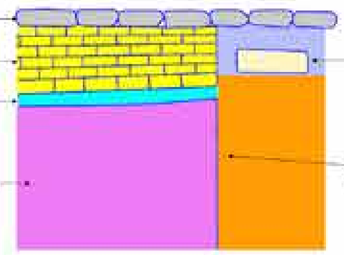


a. Face nord de la porte sud d'Amenhotep Ier

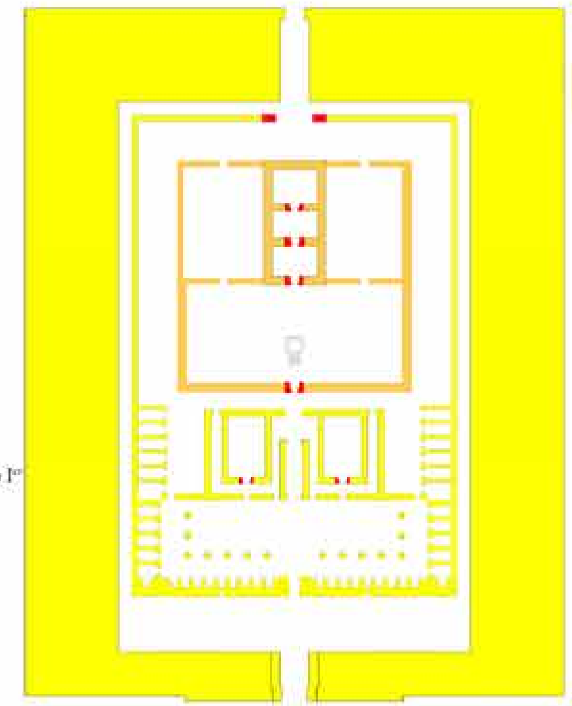
b. Tableau oriental de la porte sud d'Amenhotep Ier

Pl. 4. L'emplacement de la grande porte sud d'Amenhotep Ier.

a. Positionnement du mur en brique par rapport au mur oriental de la cour de la cachette (montage d'E. Laroze)

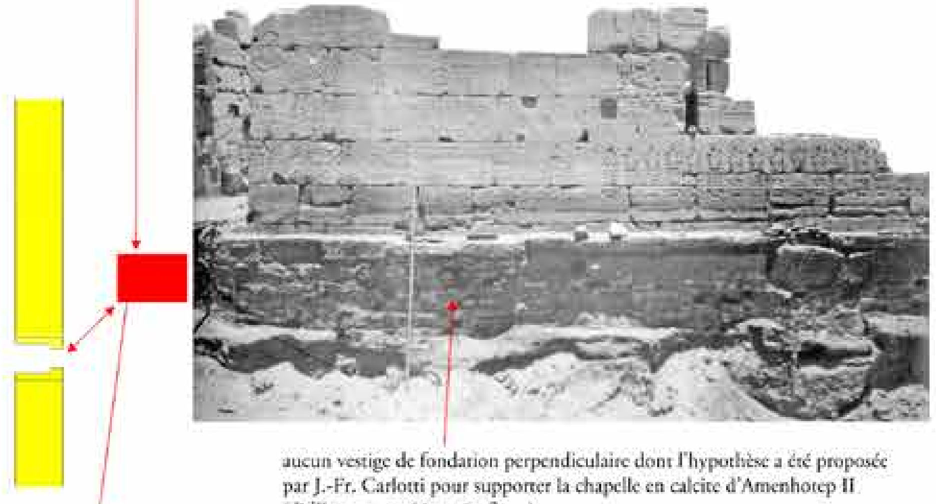


b. Coupe d'après un croquis d'un sondage de Legrain dans la partie nord-est de la cour du 7e pylône
(*Karnak dans l'objectif de G. Legrain*, fig. 17)

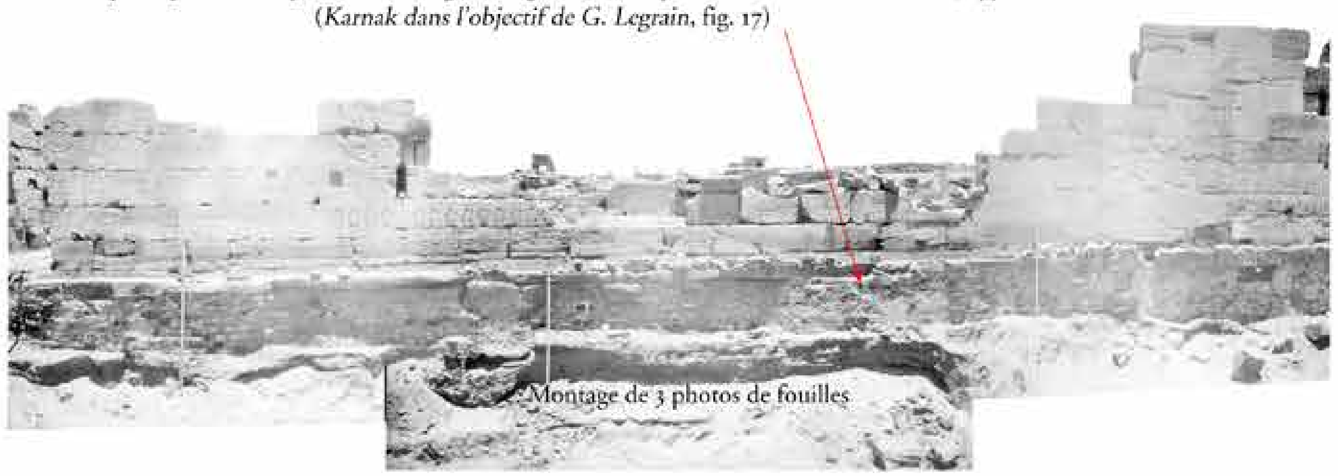


e. Blocs de la grande porte sud d'Amenhotep Ier dans l'angle sud-est de la cour de la cachette

grande faïence
recouverte
d'une feuille d'or
(*Legrain*, 4-7/115)



aucun vestige de fondation perpendiculaire dont l'hypothèse a été proposée par J.-Fr. Carlotti pour supporter la chapelle en calcite d'Amenhotep II (*BdE* 143, p. 55-66, p. 65, fig. 4)

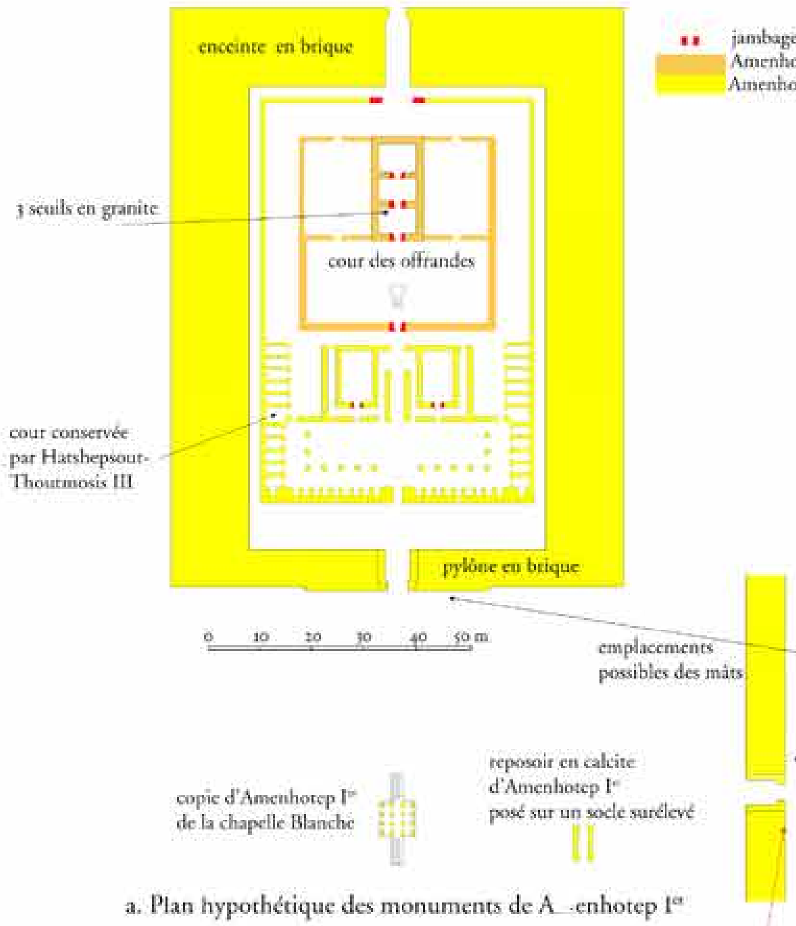


blocs de la grande porte d'Amenhotep Ier découverts ici

d. Coupe nord-sud le long des fondations du mur oriental de la cour de la cachette

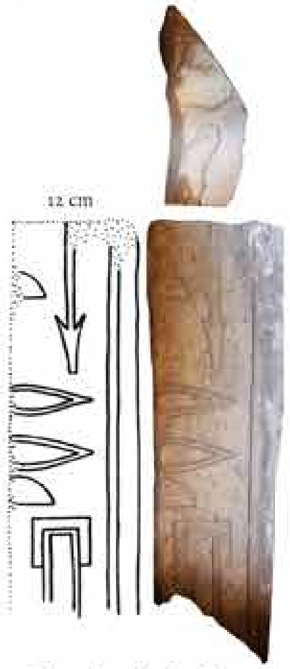
f. Coupe est-ouest perpendiculaire aux fondations du mur oriental de la cour de la cachette

Pl. 5. Les constructions restituées d'Amenhotep Ier et de Thoutmosis Ier.

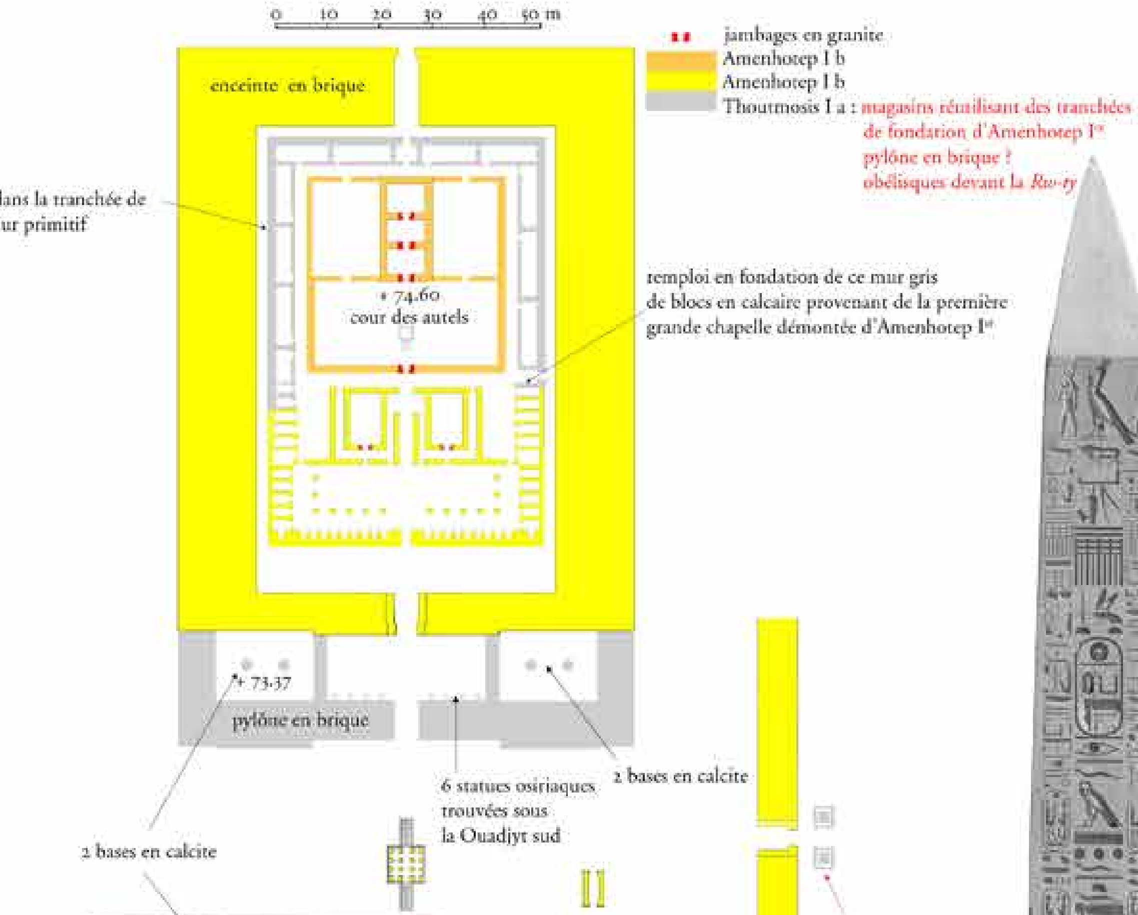


a. Plan hypothétique des monuments de A enhotep Ier

b. Face sud du linteau de la porte sud, *Rw-ty* d'Amenhotep Ier



c. Chambranle de niche de mât, en calcaire tendre, mentionnant la *Rw-ty* remployé dans le môle nord du 5e pylône



e. Plan hypothétique des monuments de Thoutmosis Ier

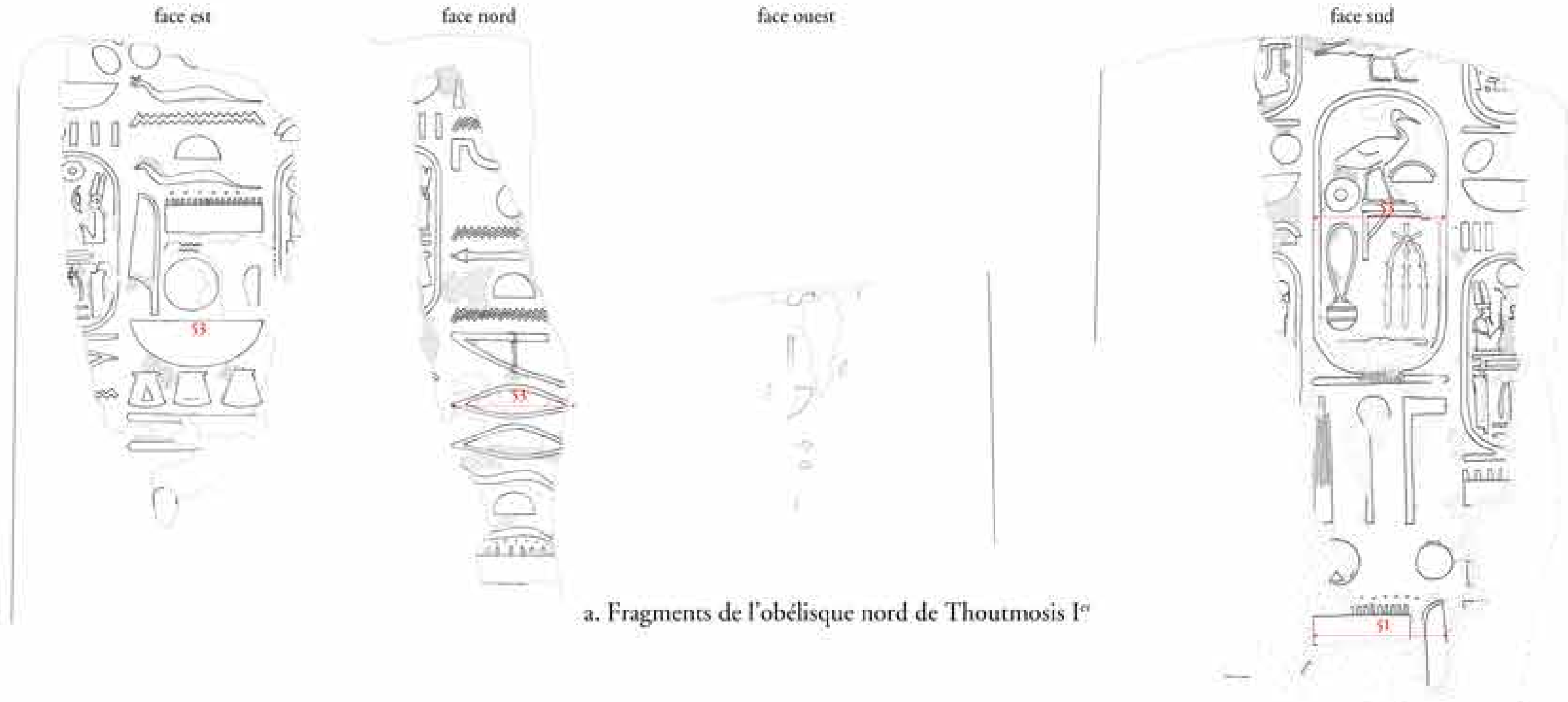
d. Six statues osiriaques polychromes en grès rouge (315 x 61 cm) attribuées au début du Nouvel Empire (*Karnak 11*, p. 261)

Stockholm OR60, MME 1872-17

Musée de Louqsor J236, cfeetk 42362

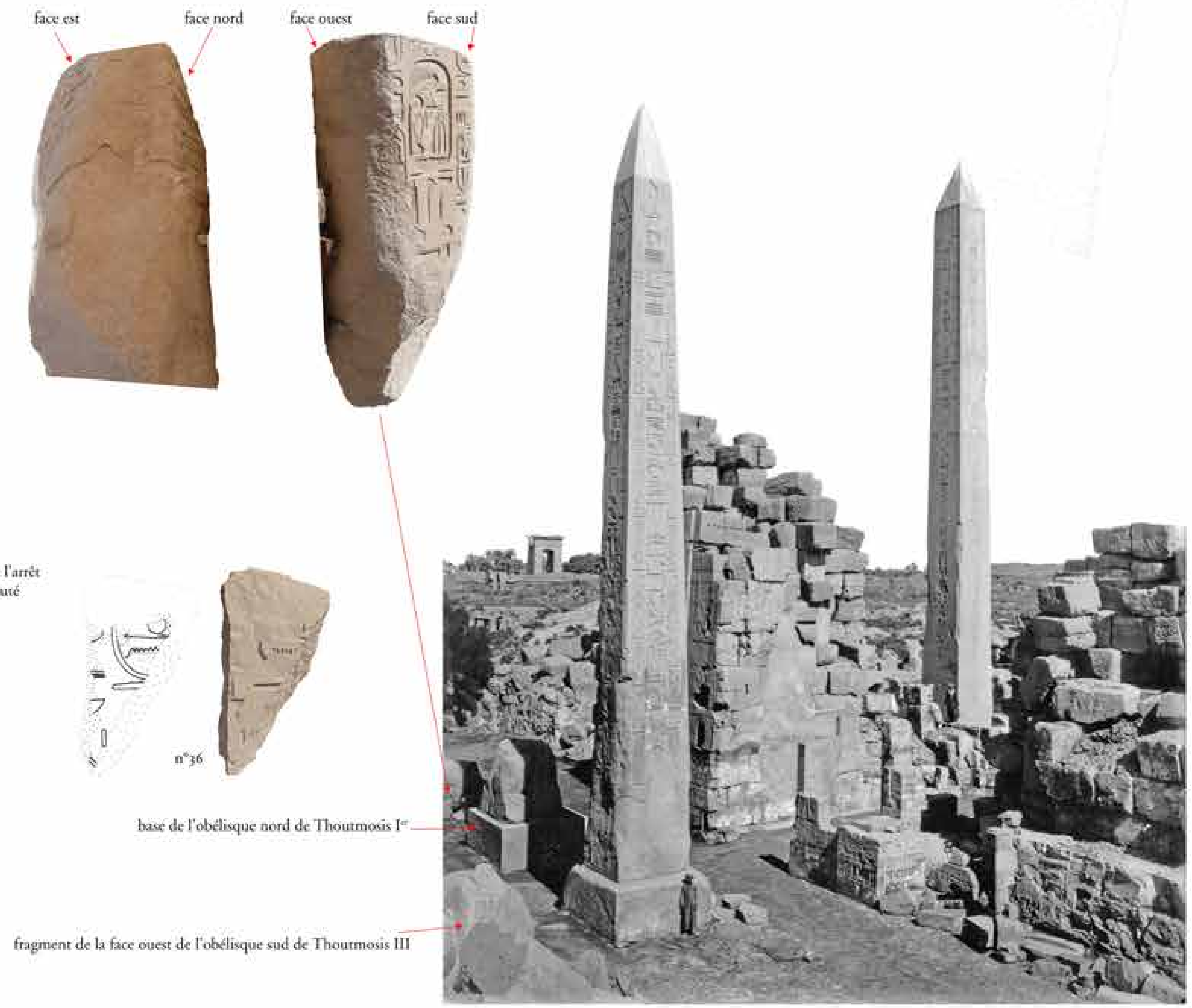
f. Obélisque sud de Thoutmosis Ier

Pl. 6. Les obélisques de Thoutmosis Ier.



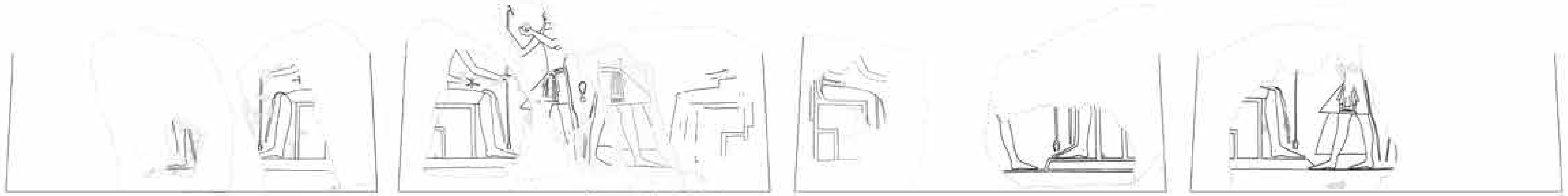
a. Fragments de l'obélisque nord de Thoutmosis Ier

b. Obélisque sud de Thoutmosis Ier

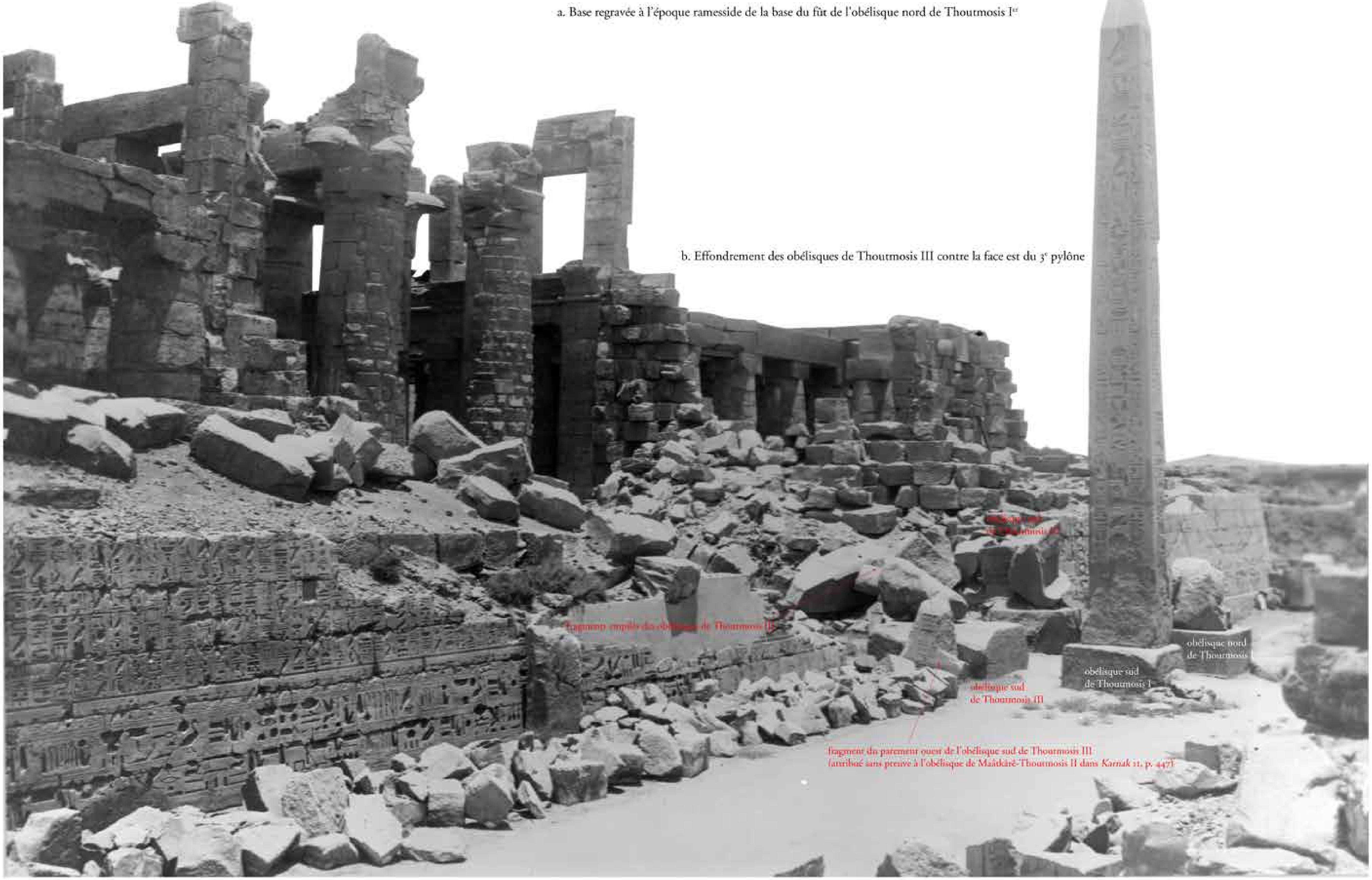


c. L'obélisque sud de Thoutmosis Ier devant le 4e pylône

Pl. 7. Les obélisques de Thoutmosis Ier.

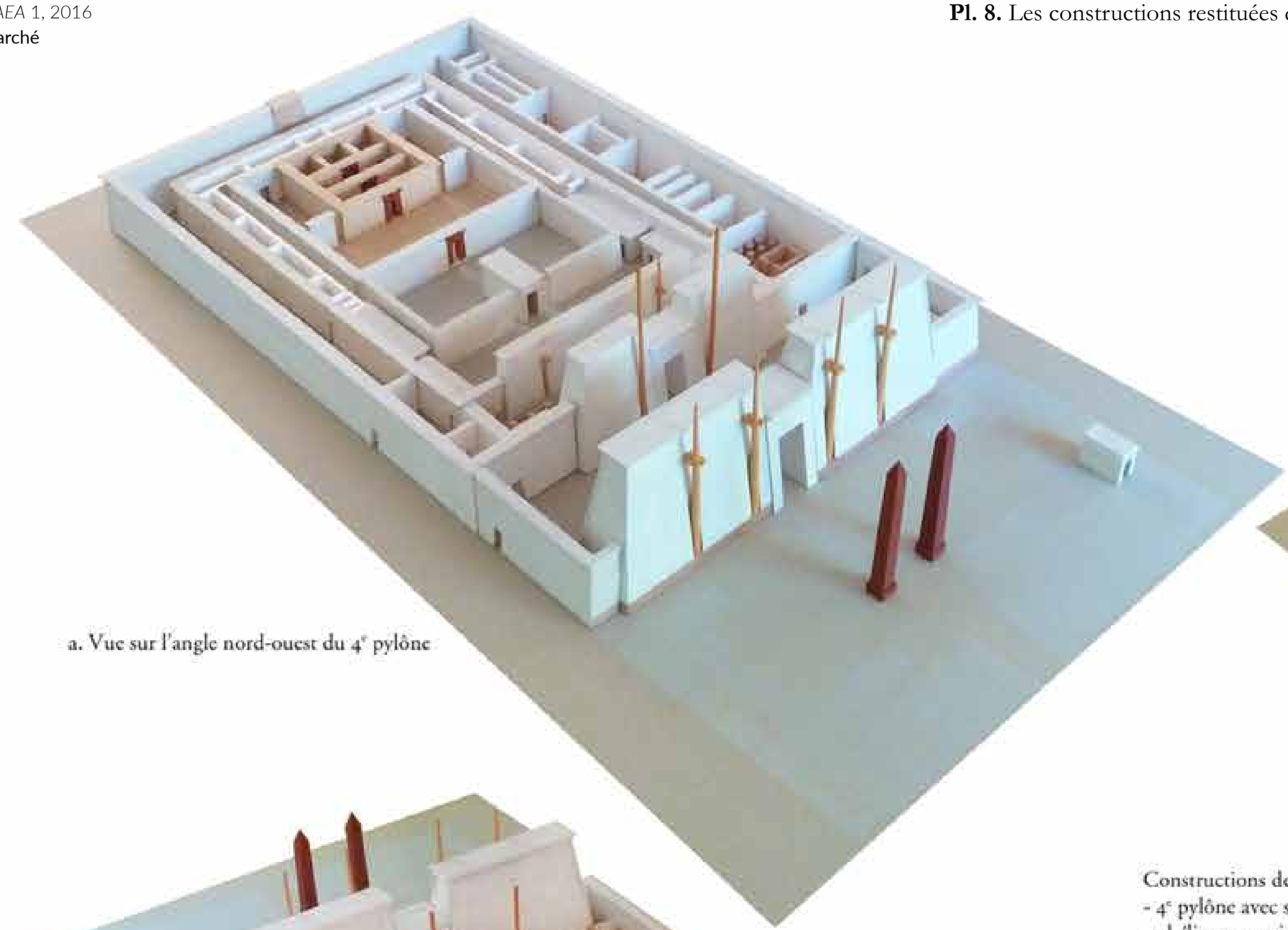


a. Base regravée à l'époque ramesside de la base du fût de l'obélisque nord de Thoutmosis Ier

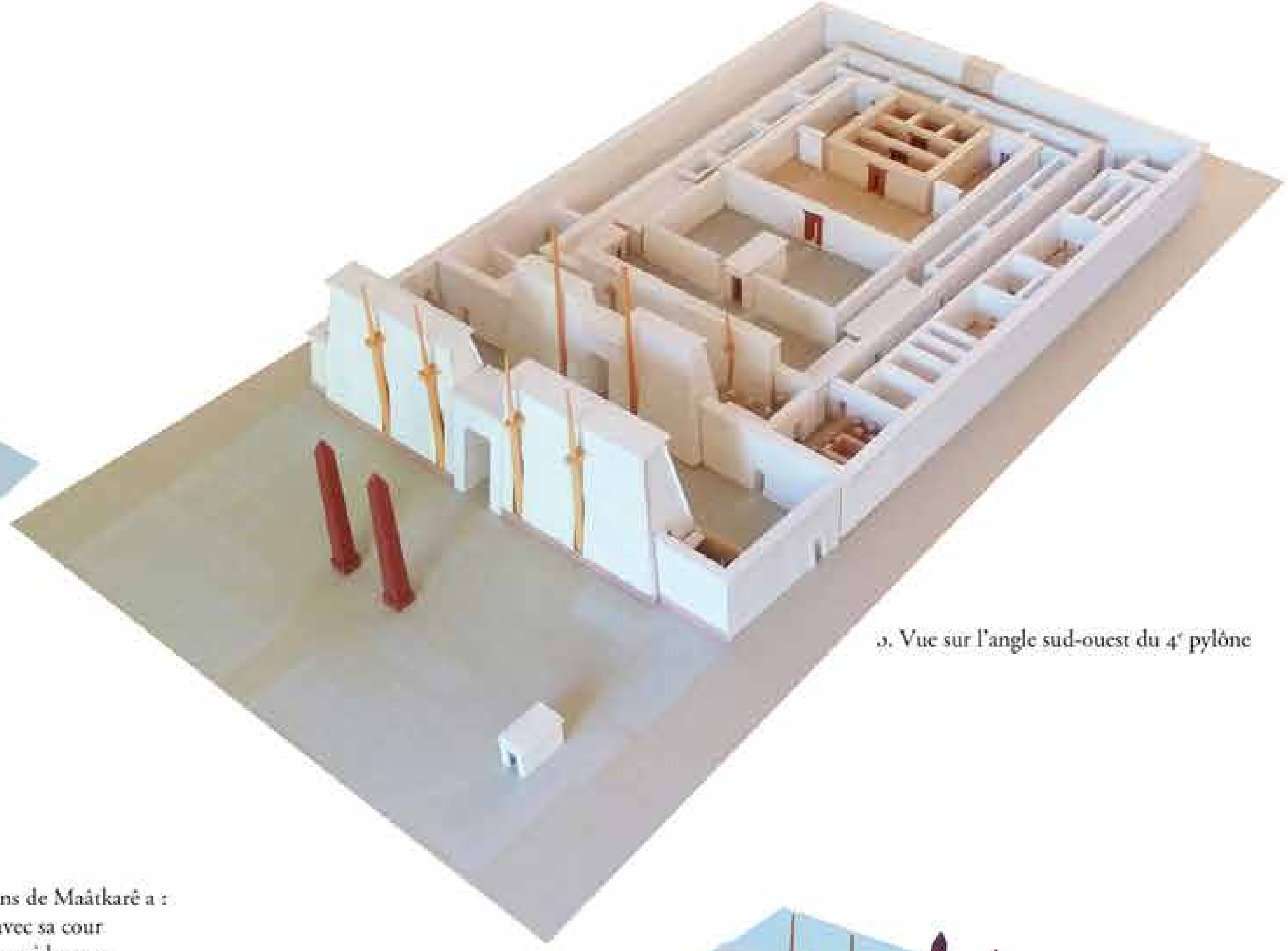


b. Effondrement des obélisques de Thoutmosis III contre la face est du 3e pylône

Pl. 8. Les constructions restituées de Maâtkarê, phase a.

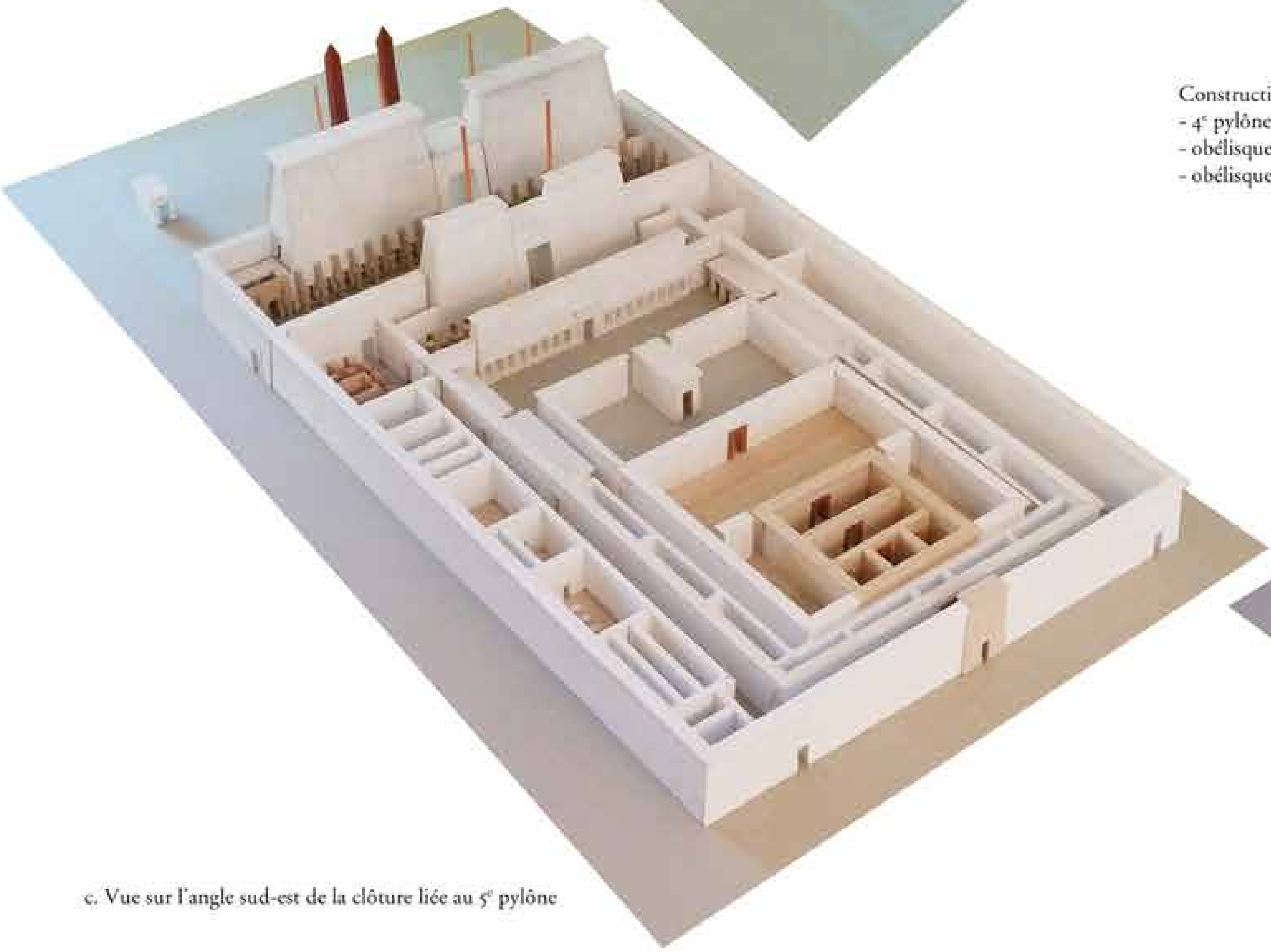


a. Vue sur l'angle nord-ouest du 4[e] pylône

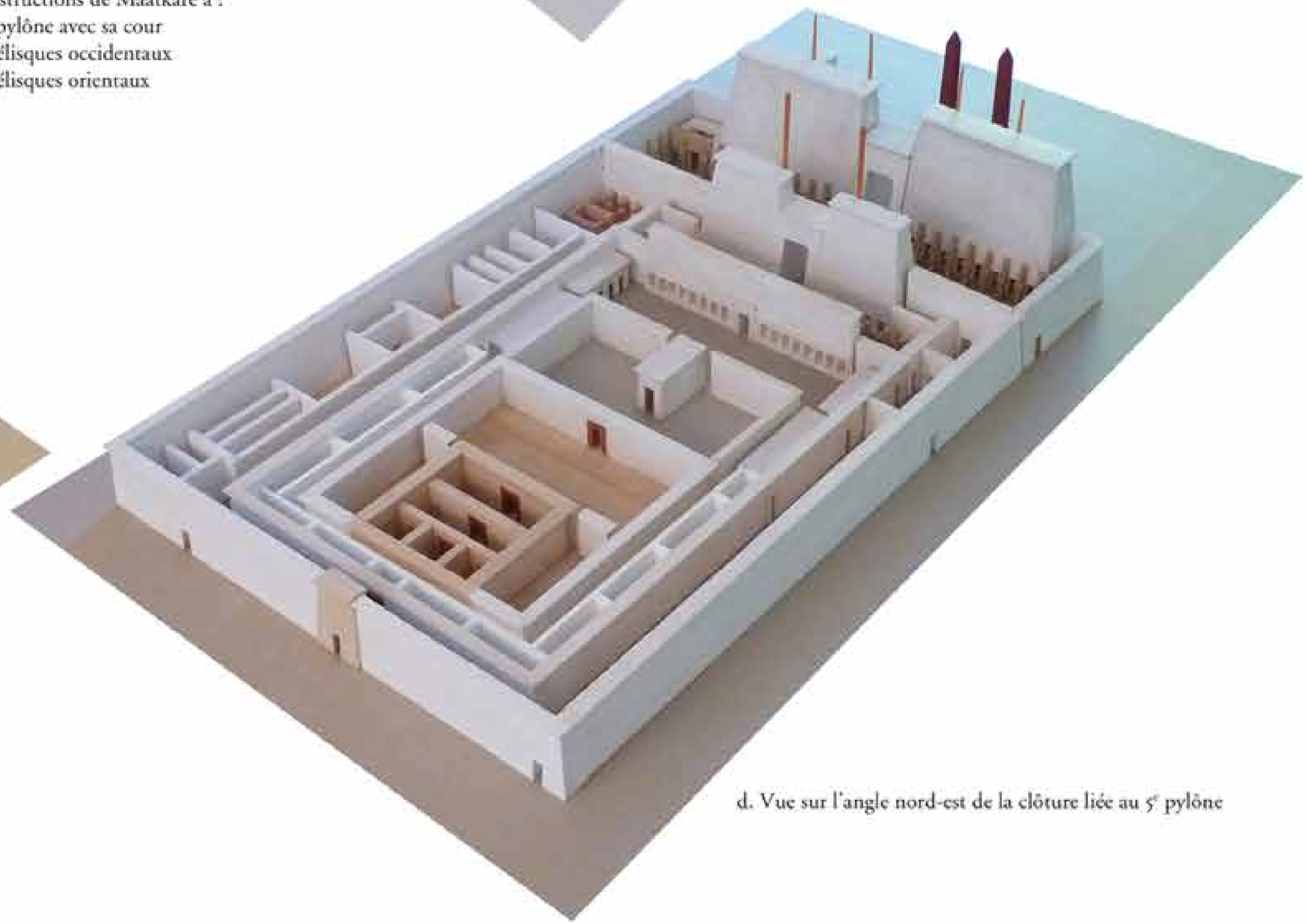


b. Vue sur l'angle sud-ouest du 4[e] pylône

Constructions de Maâtkarê a :
- 4[e] pylône avec sa cour
- obélisques occidentaux
- obélisques orientaux

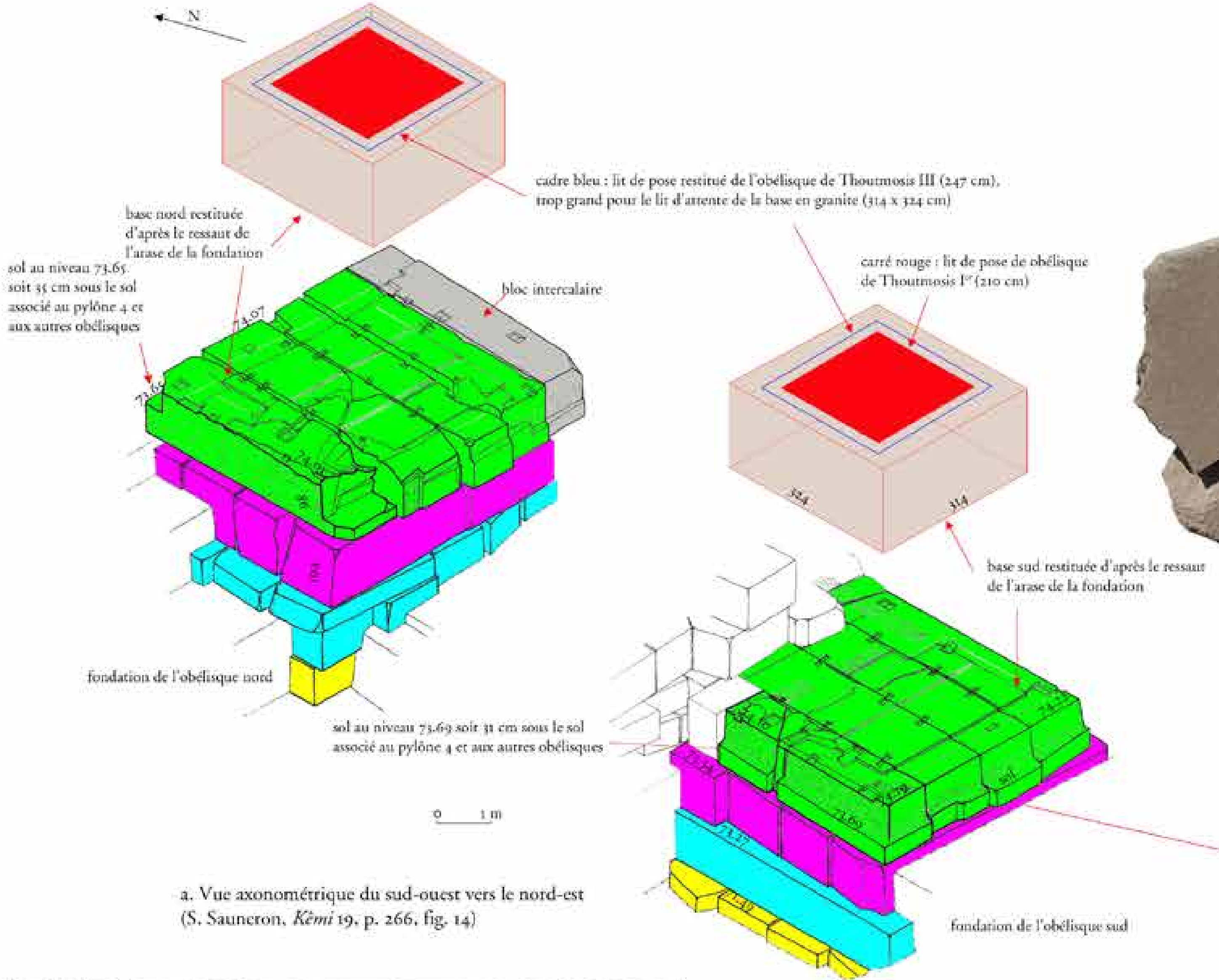


c. Vue sur l'angle sud-est de la clôture liée au 5[e] pylône

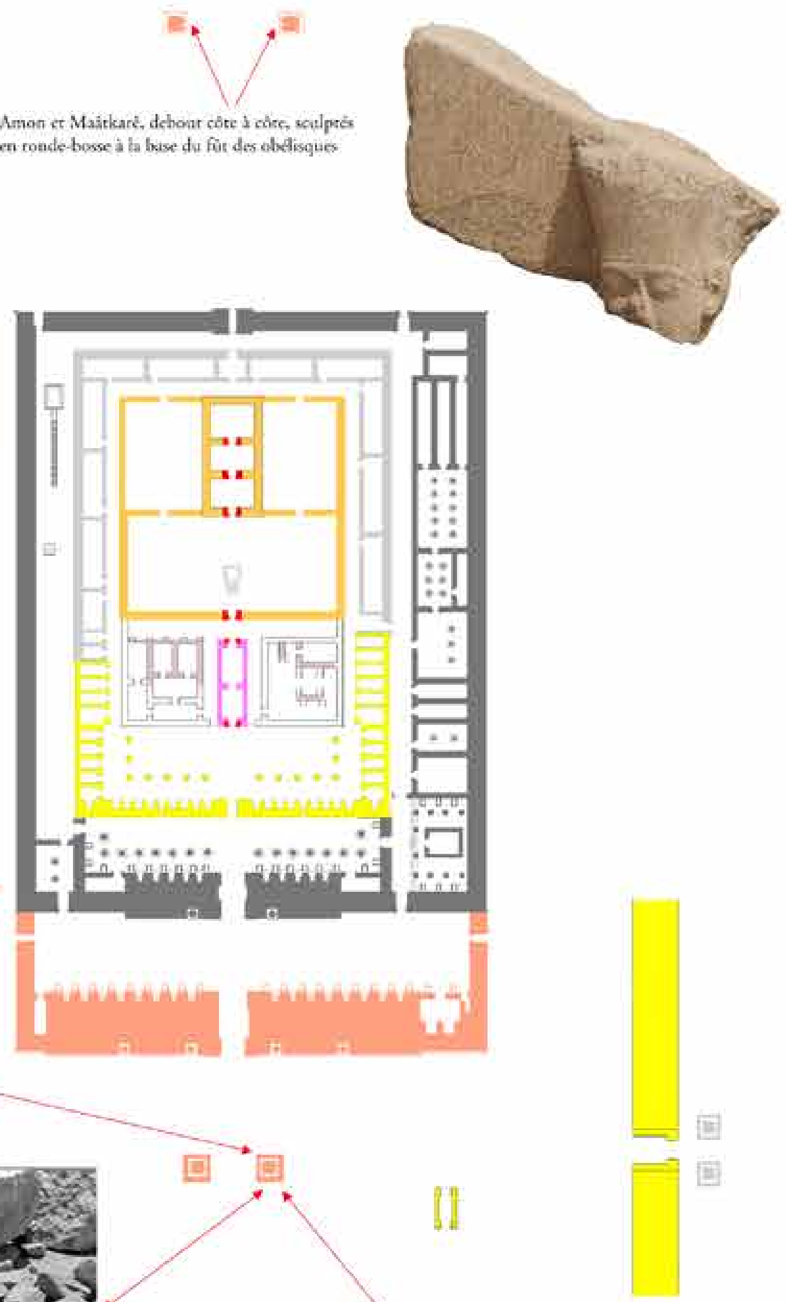


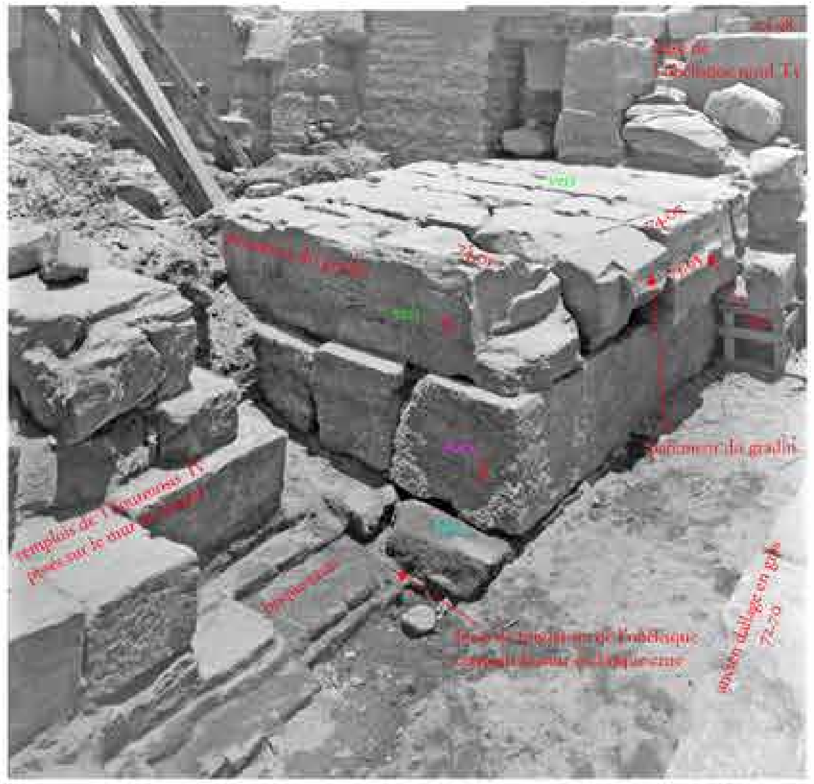
d. Vue sur l'angle nord-est de la clôture liée au 5[e] pylône

Pl. 9. Les constructions restituées de Maâtkarê, phase a.



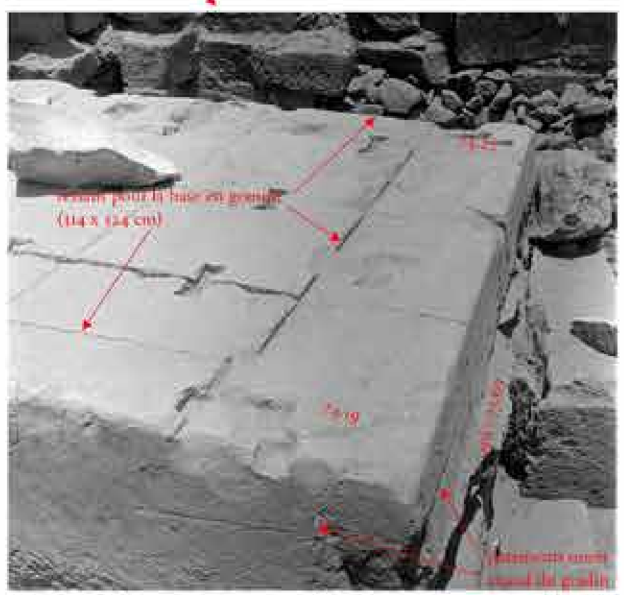
a. Vue axonométrique du sud-ouest vers le nord-est
(S. Sauneron, *Kêmi* 19, p. 266, fig. 14)





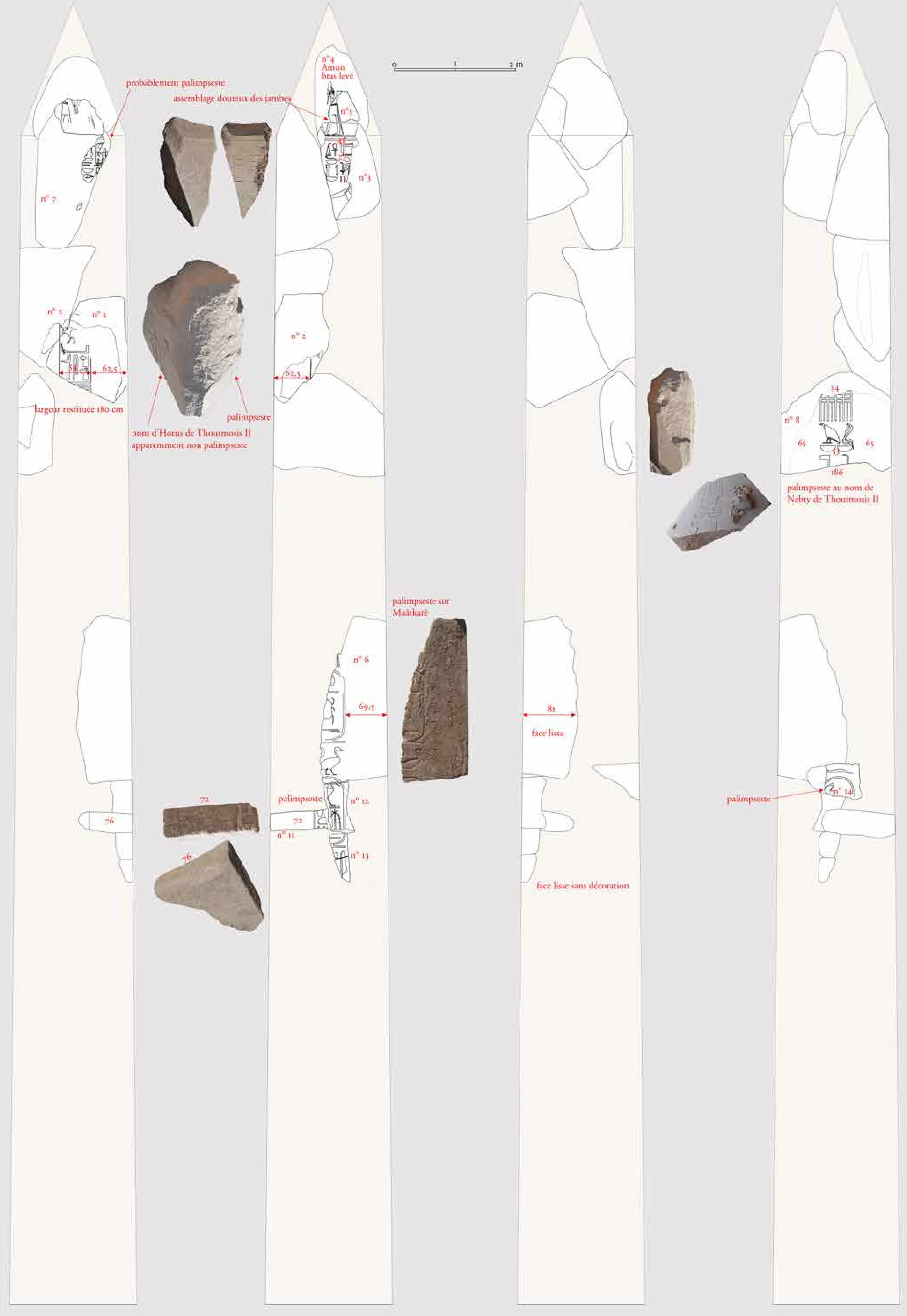
b. Fondation d'obélisque sous le môle nord du 3e pylône : vue vers le nord-ouest

c. Fondation d'obélisque sous le môle sud du 3e pylône : vue vers le sud-est



d. Fondation d'obélisque sous le môle sud du 3e pylône : vue vers l'est

Pl. 10. Les obélisques au nom de Maâtkarê, phase a, regravés au nom de Thoutmosis II.



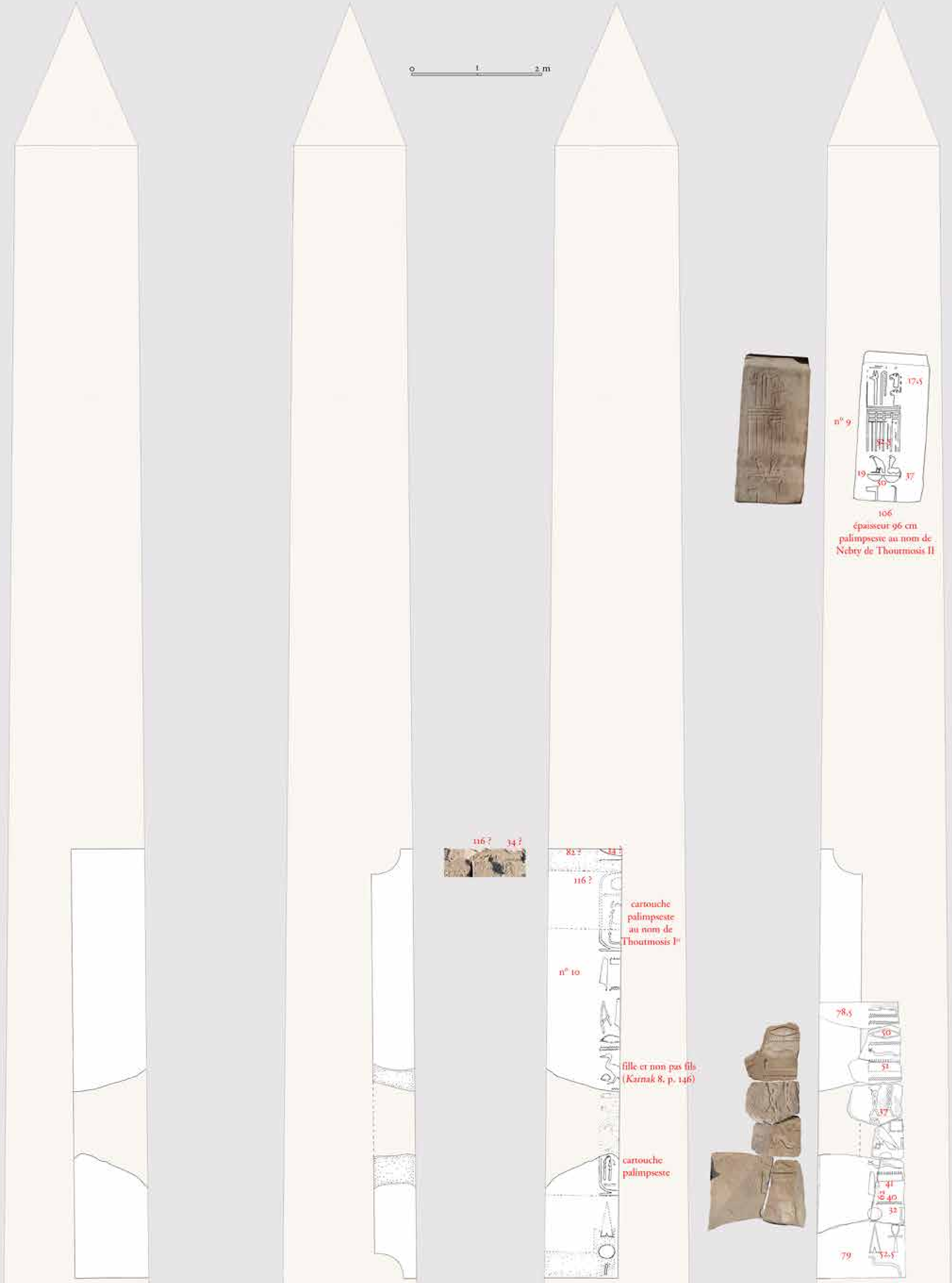
a. Face ouest si restitué au sud
Face nord si restitué au nord

b. Face sud si restitué au sud
Face ouest si restitué au nord

c. Face est si restitué au sud
Face sud si restitué au nord

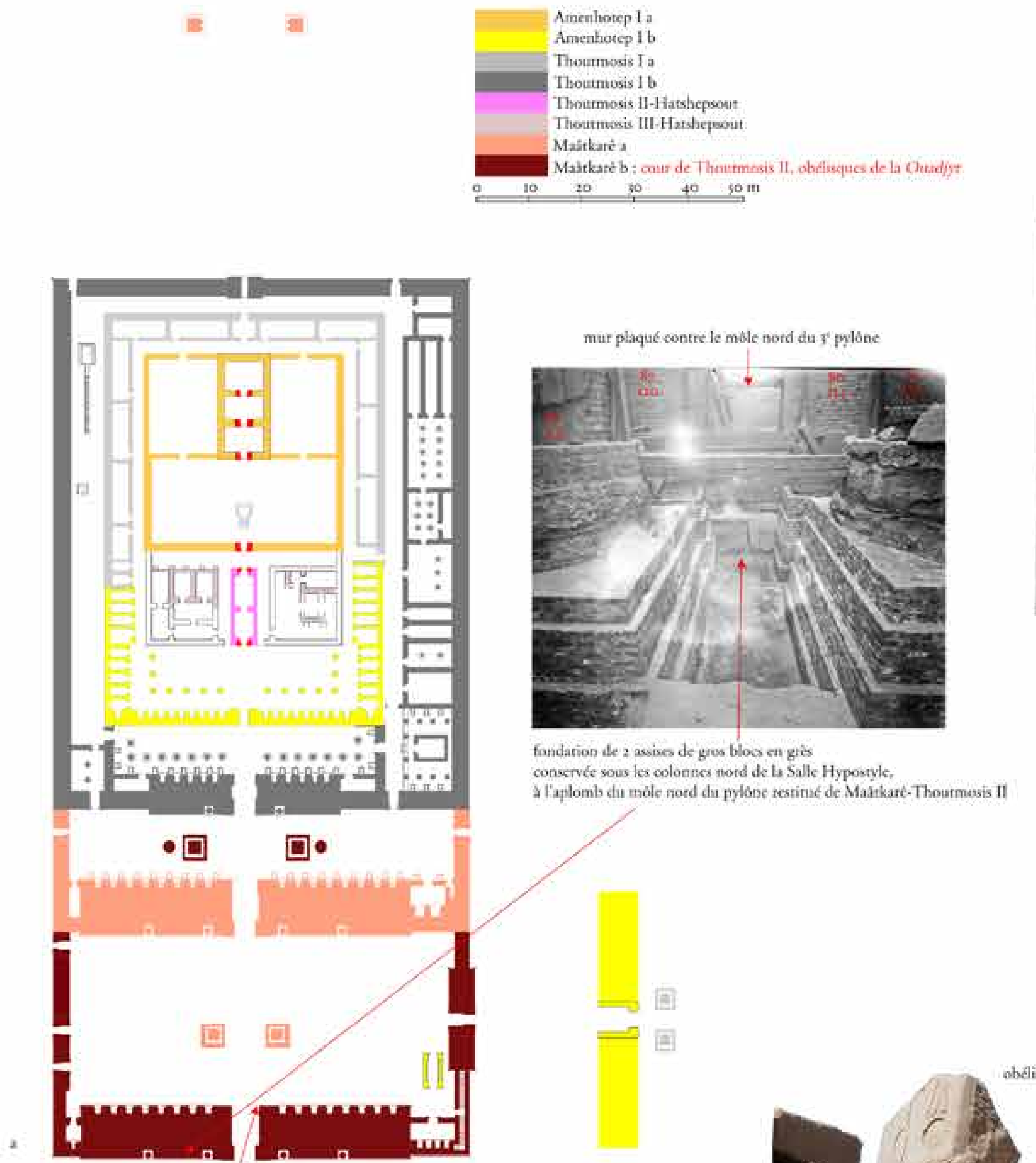
d. Face nord si restitué au sud
Face est si restitué au nord

Pl. 11. Les obélisques au nom de Maâtkarê, phase a, regravés au nom de Thoutmosis II.

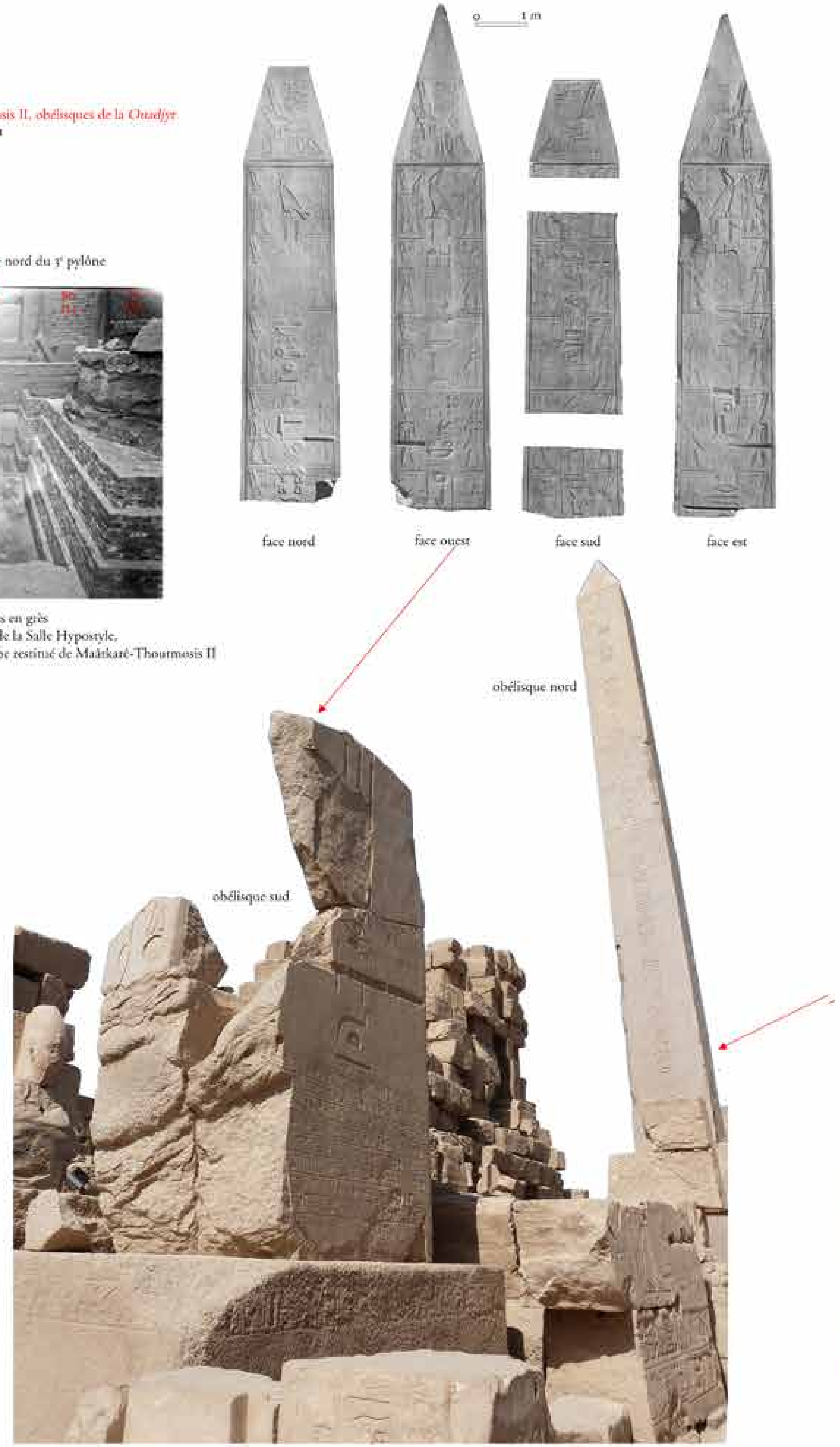


fragments d'obélisque remployés en couverture et en soubassement du vestibule de la chapelle de Philippe Arrhidée

Pl. 12. Les constructions restituées de Maâtkarê, phase b.

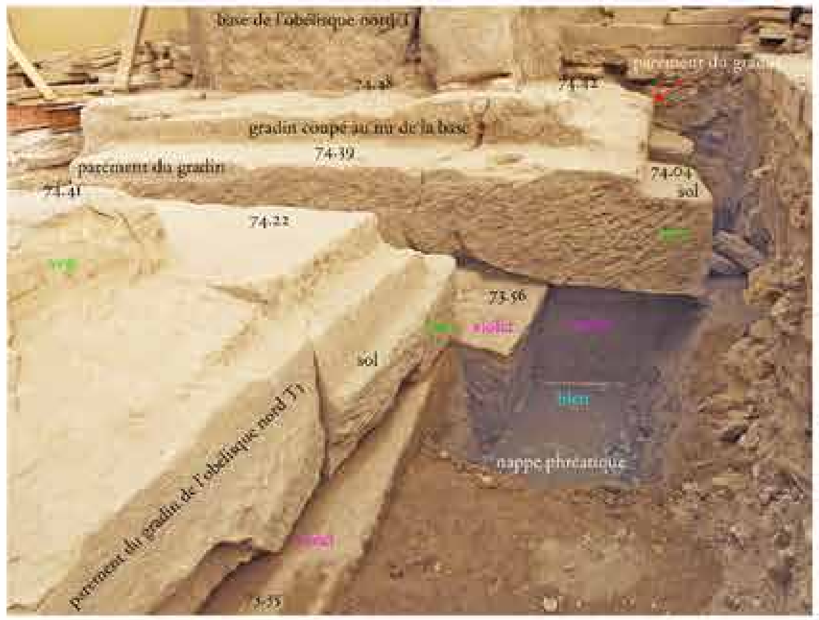


b. Bloc MPA 475 regravé du nom d'Horus de Thoutmosis II sur celui de Maâtkarê



c. Obélisques de Maâtkarê dans la Ouadjyt

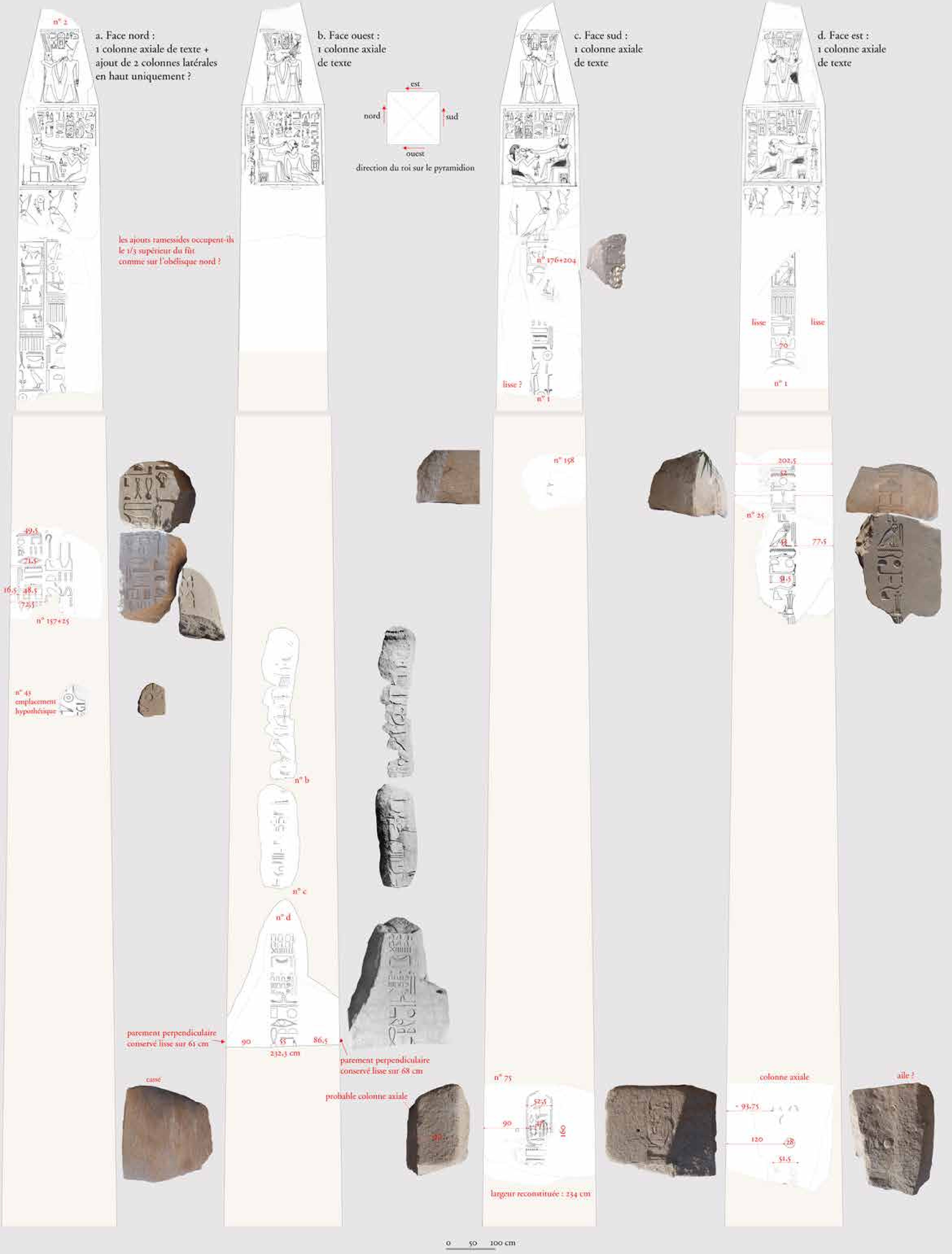
Pl. 13. Les constructions restituées de Thoutmosis III, phase c.



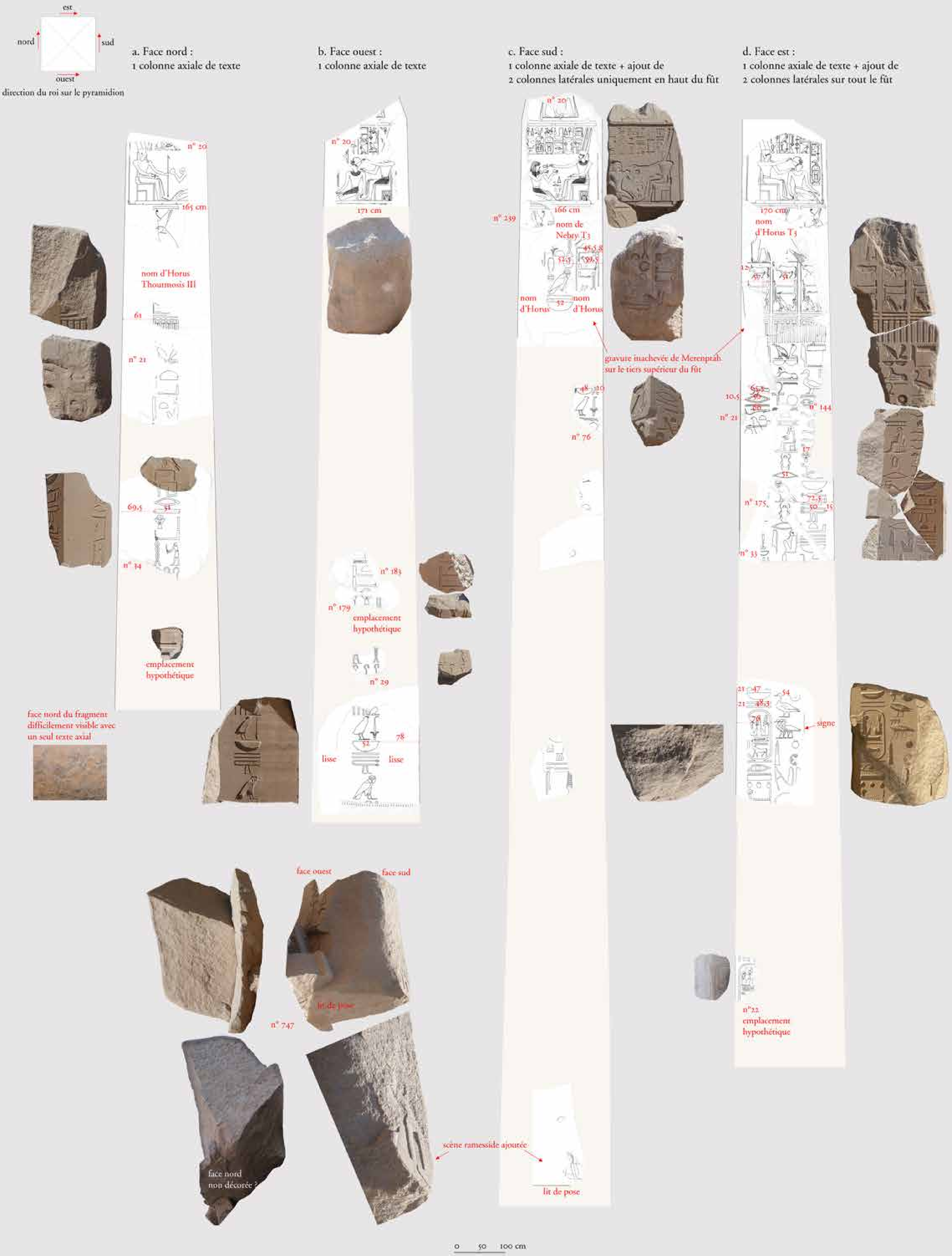
a. Fondation commune aux deux obélisques nord

b. Obélisque sud de Thoutmosis Ier démonté et replacé devant le 4e pylône

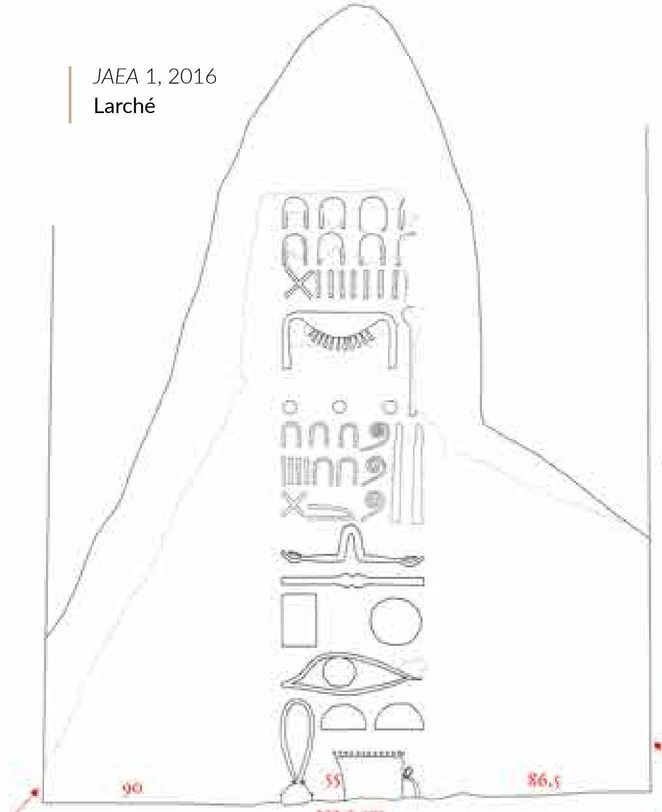
Pl. 14. L'obélisque sud au nom de Thoutmosis III, phase c.

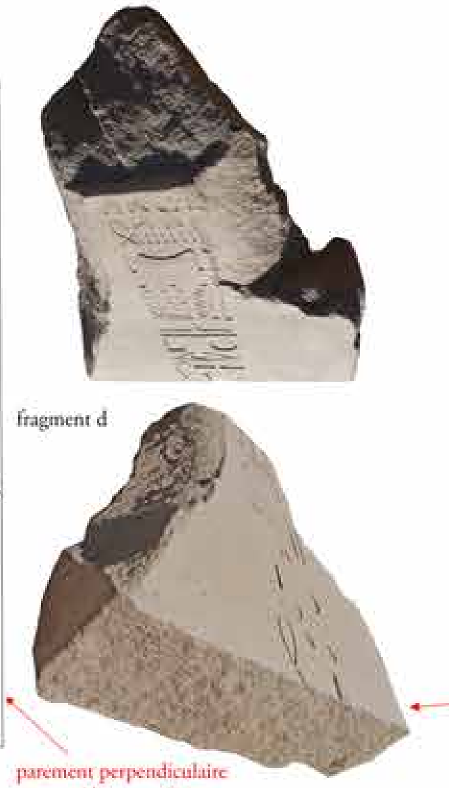


Pl. 15. L'obélisque nord au nom de Thoutmosis III, phase c.

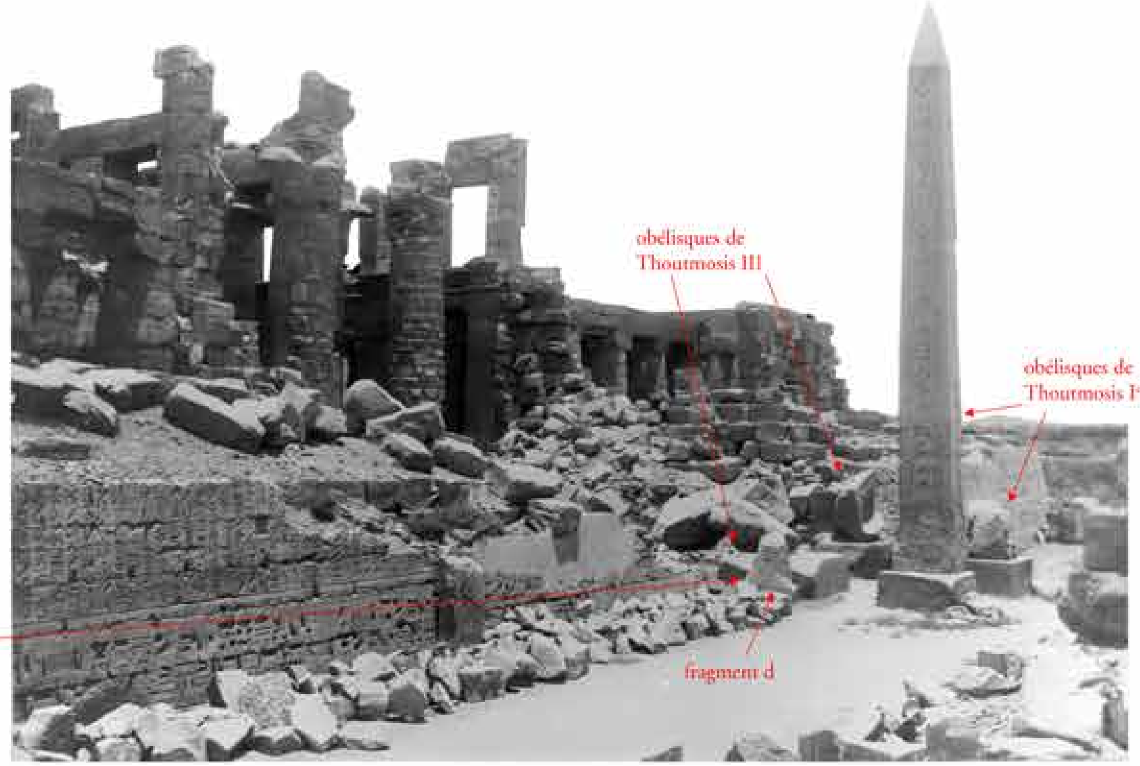


Pl. 16. Les fragments b, c, d et 75 de la partie inférieure de l'obélisque sud de Thoutmosis III, phase c.

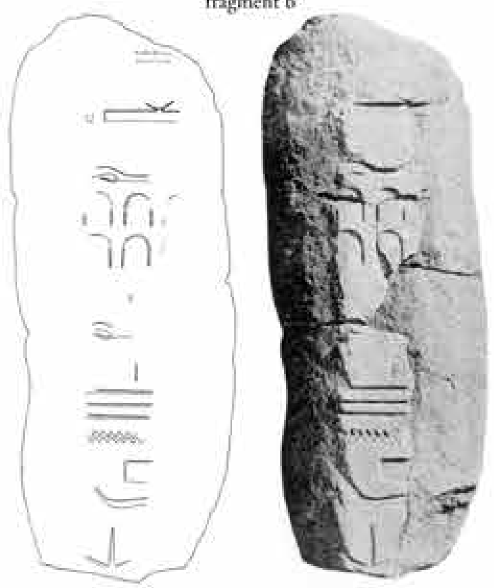




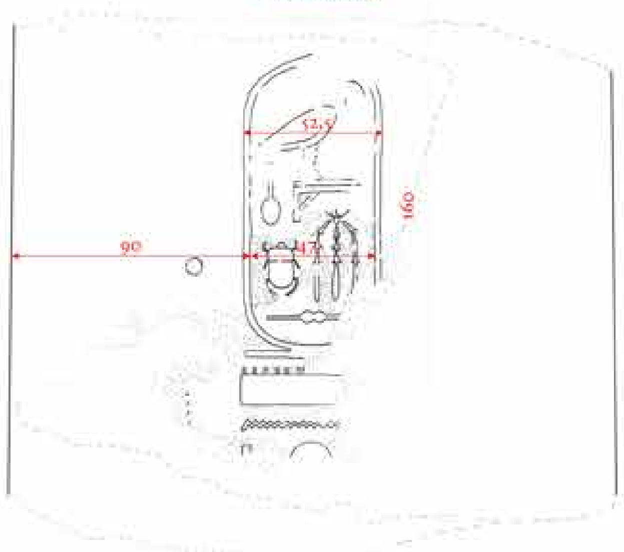
fragment d



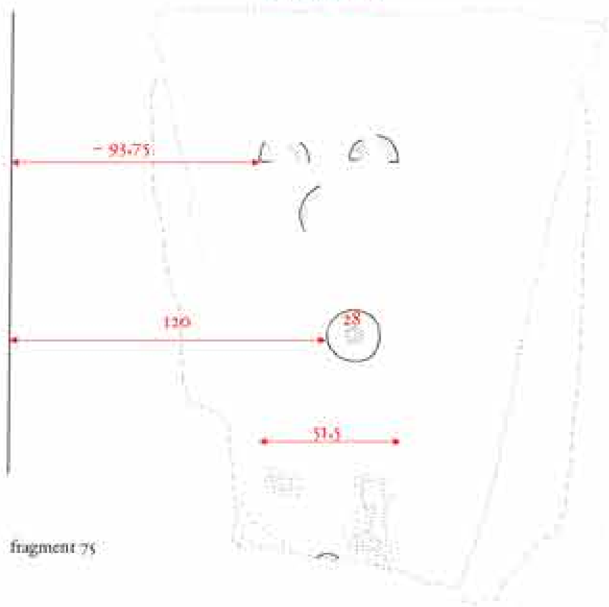
fragment b



fragment c



largeur reconstituée : 234 cm



fragment 75

0 50 100 cm

a. Face ouest

b. Face sud

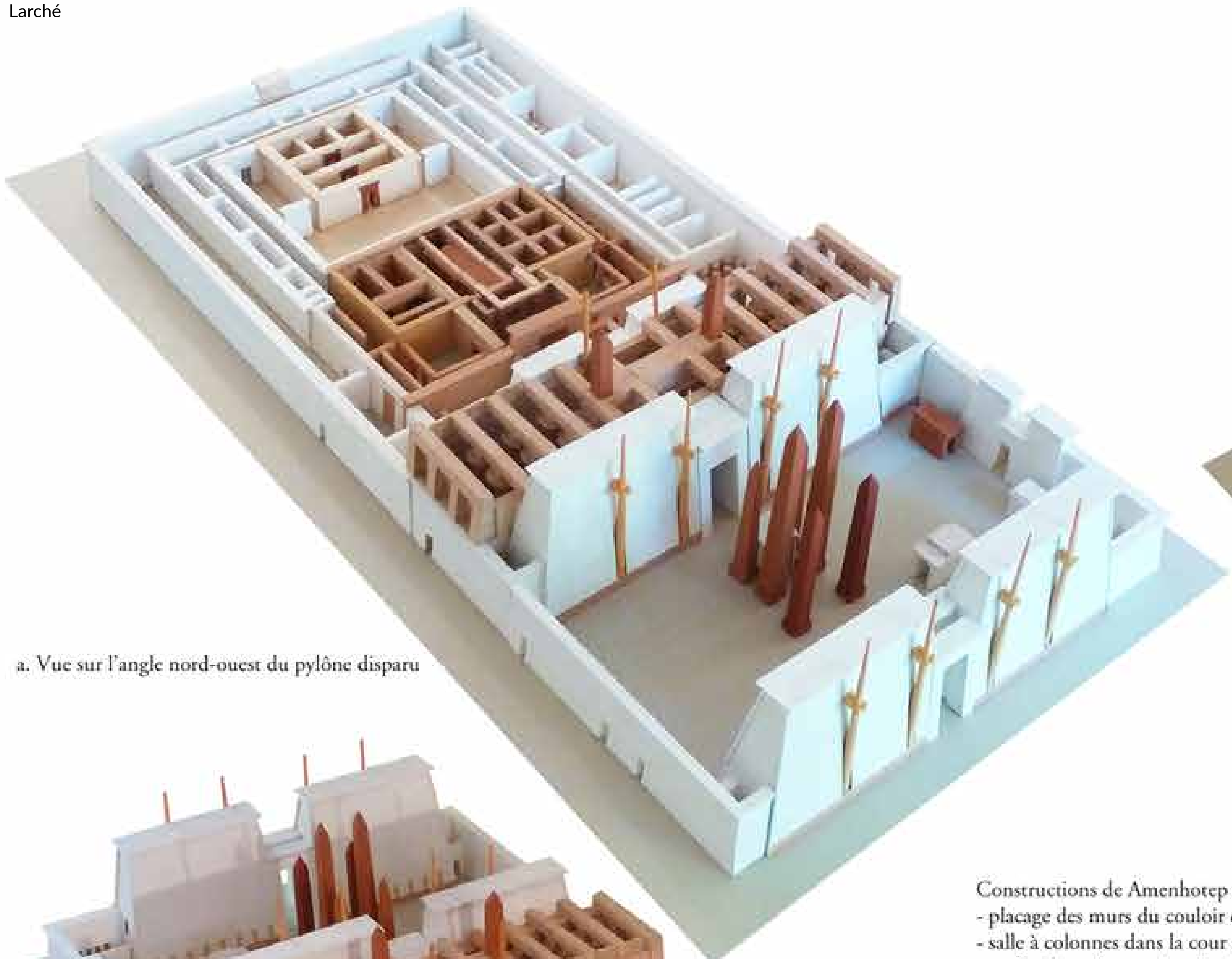
c. Face est

d. Face nord

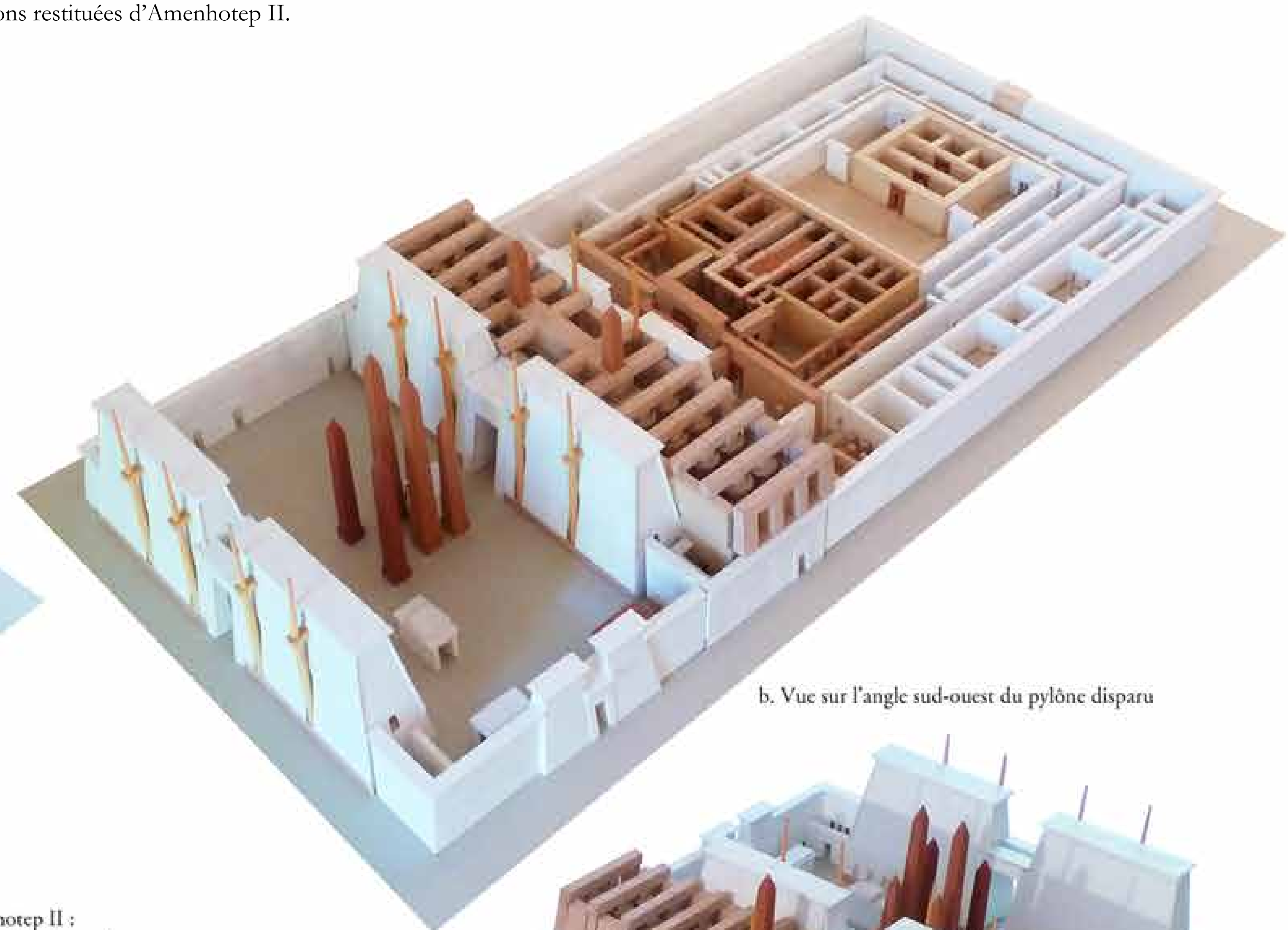
Texte reconstitué de la face ouest de l'obélisque sud de Thoutmosis III d'après *Karnak* 11.2, p. 448, fig. 2

0 1 m

Pl. 17. Les constructions restituées d'Amenhotep II.

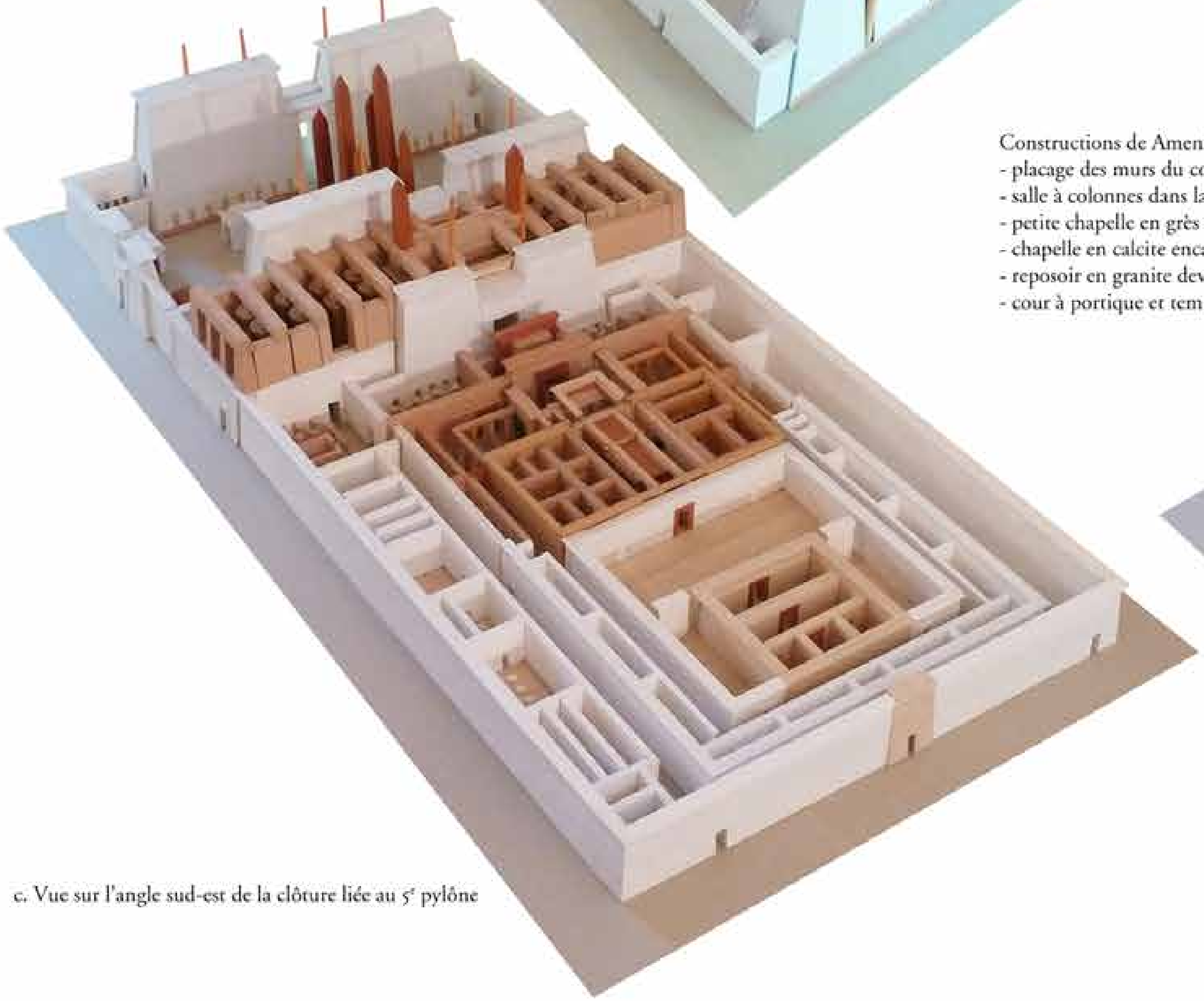


a. Vue sur l'angle nord-ouest du pylône disparu

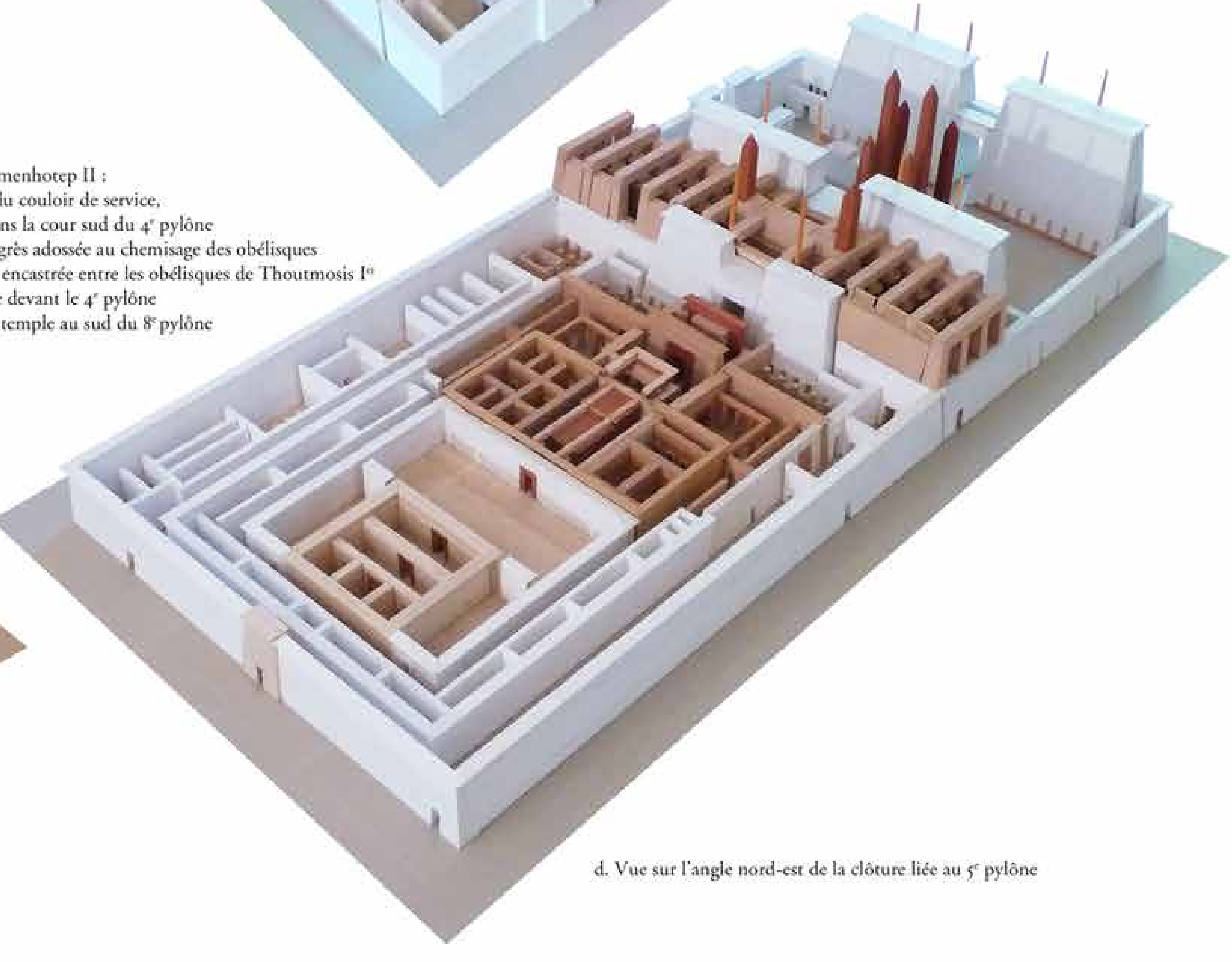


b. Vue sur l'angle sud-ouest du pylône disparu

Constructions de Amenhotep II :
- placage des murs du couloir de service,
- salle à colonnes dans la cour sud du 4e pylône
- petite chapelle en grès adossée au chemisage des obélisques
- chapelle en calcite encastrée entre les obélisques de Thoutmosis Ier
- reposoir en granite devant le 4e pylône
- cour à portique et temple au sud du 8e pylône

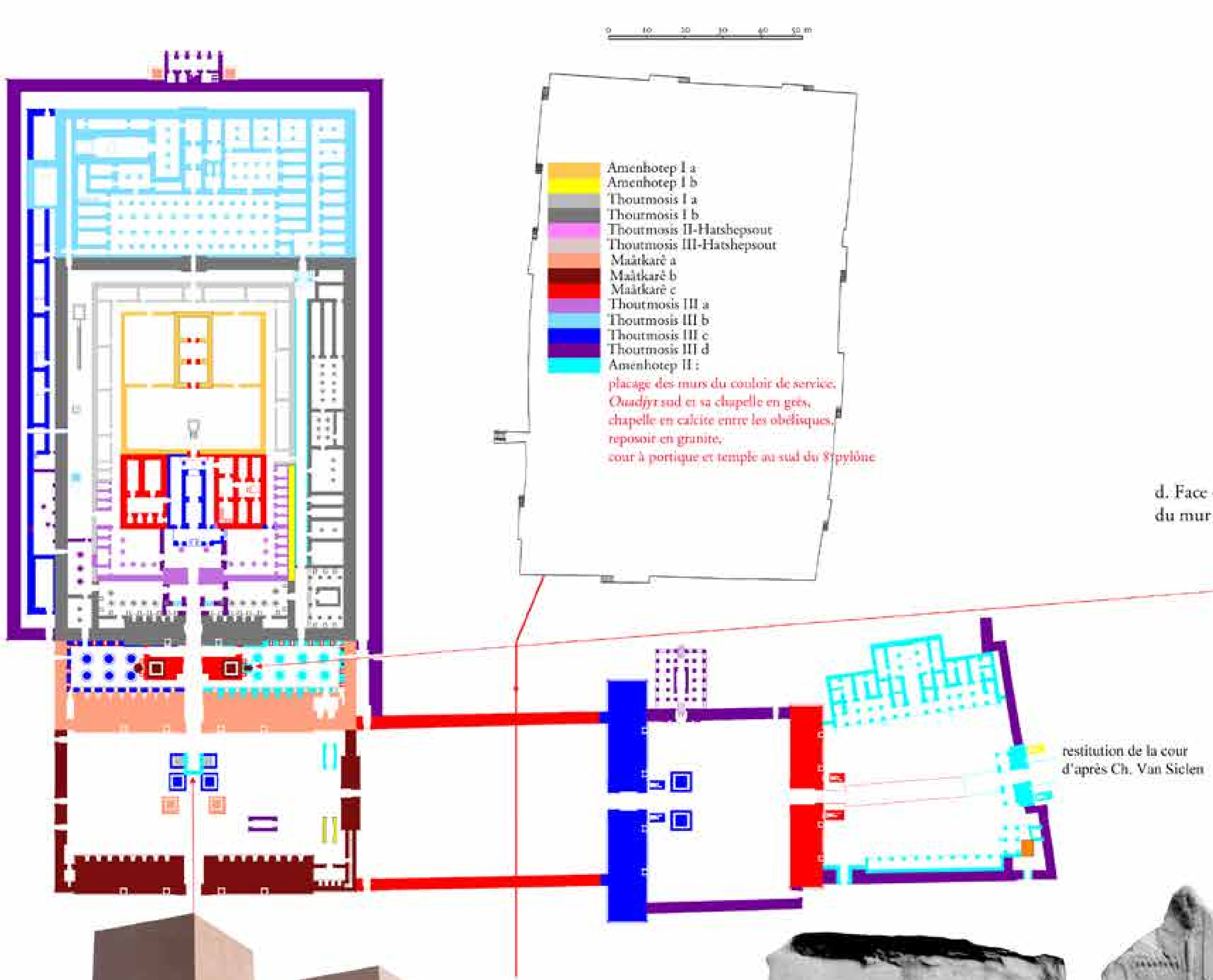


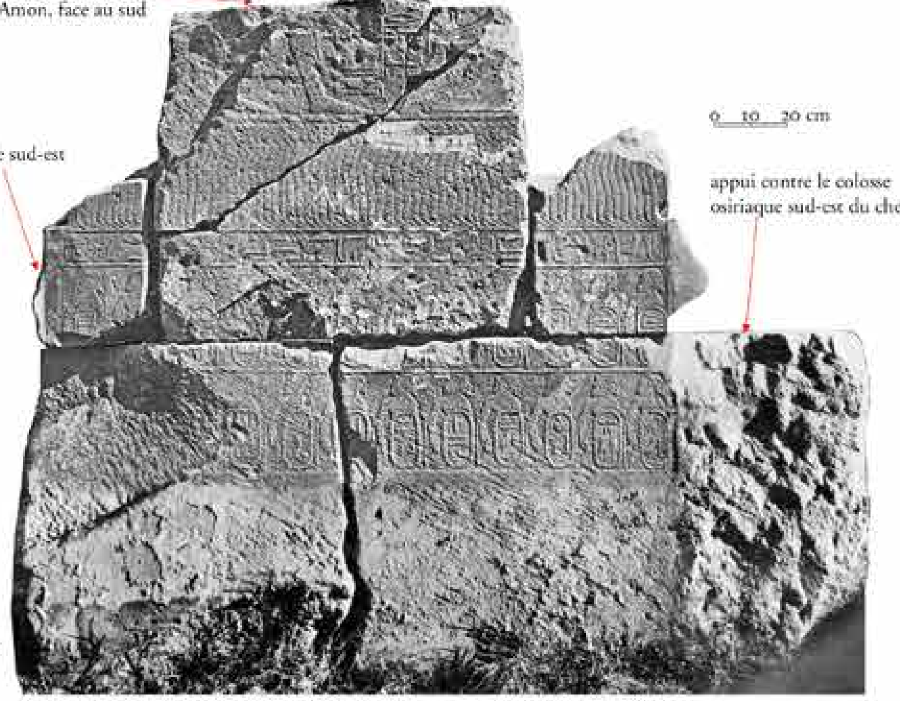
c. Vue sur l'angle sud-est de la clôture liée au 5e pylône



d. Vue sur l'angle nord-est de la clôture liée au 5e pylône

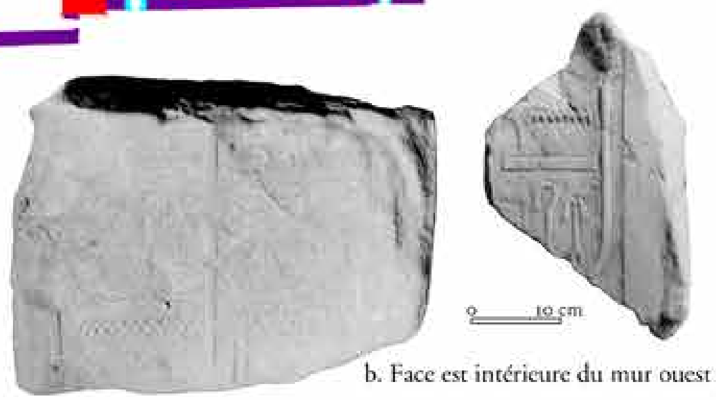
Pl. 18. Les constructions restituées d'Amenhotep II.





d. Face orientale extérieure
du mur est du naos

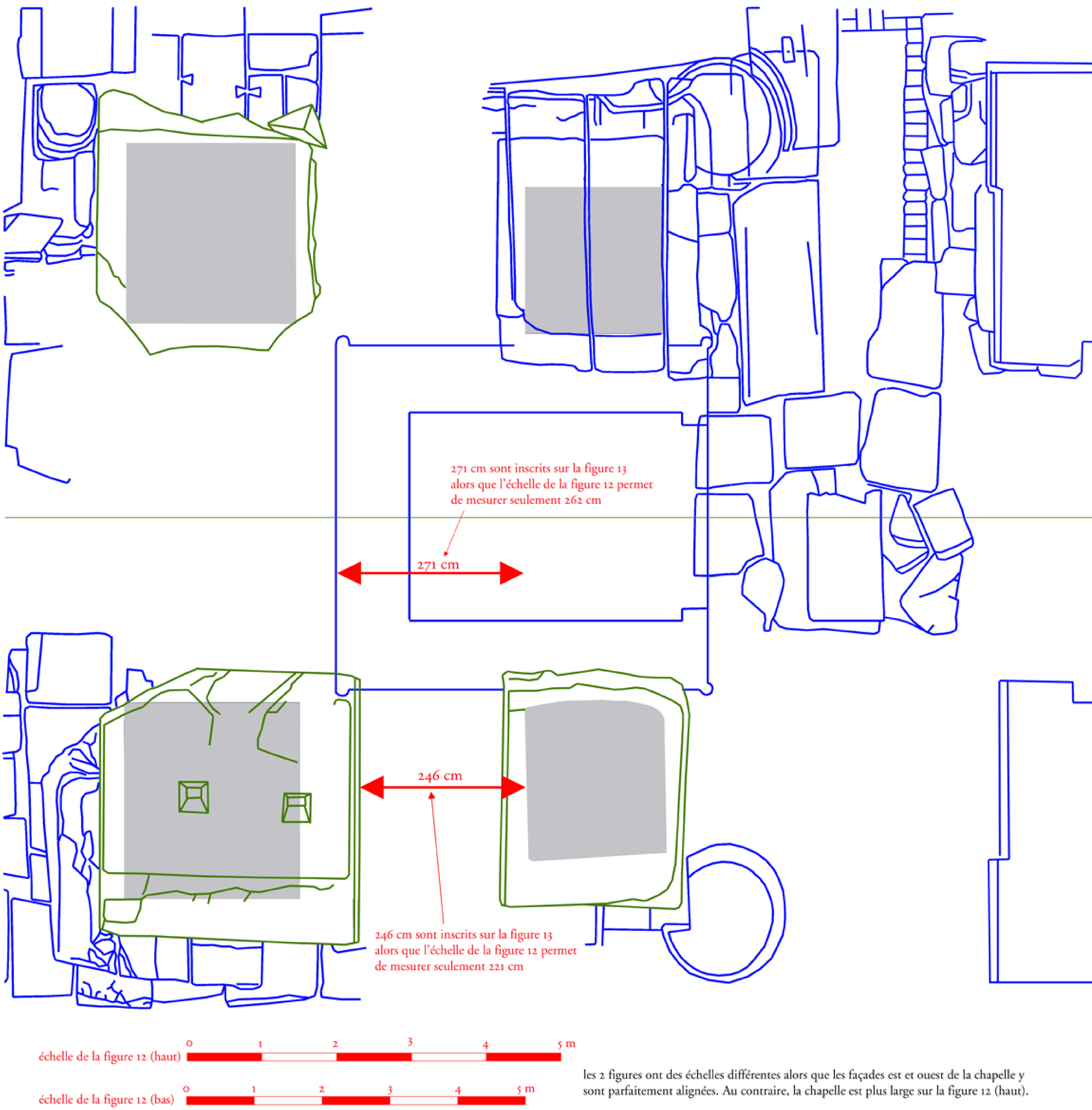
e. Face ouest intérieure du mur est du naos : le prêtre *sem*, face au nord, fait une offrande au roi, face au sud

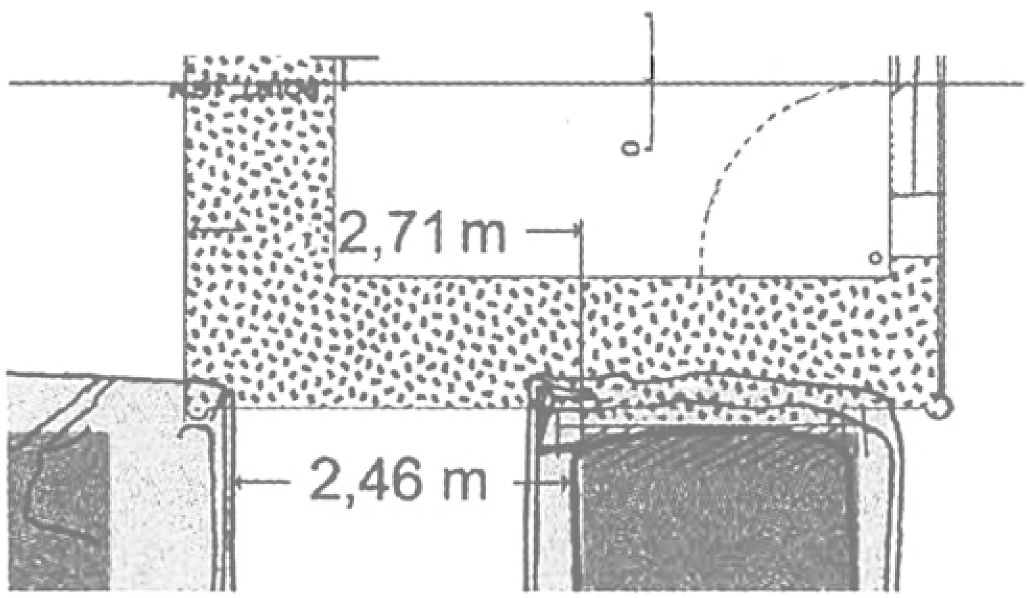


b. Face est intérieure du mur ouest du naos

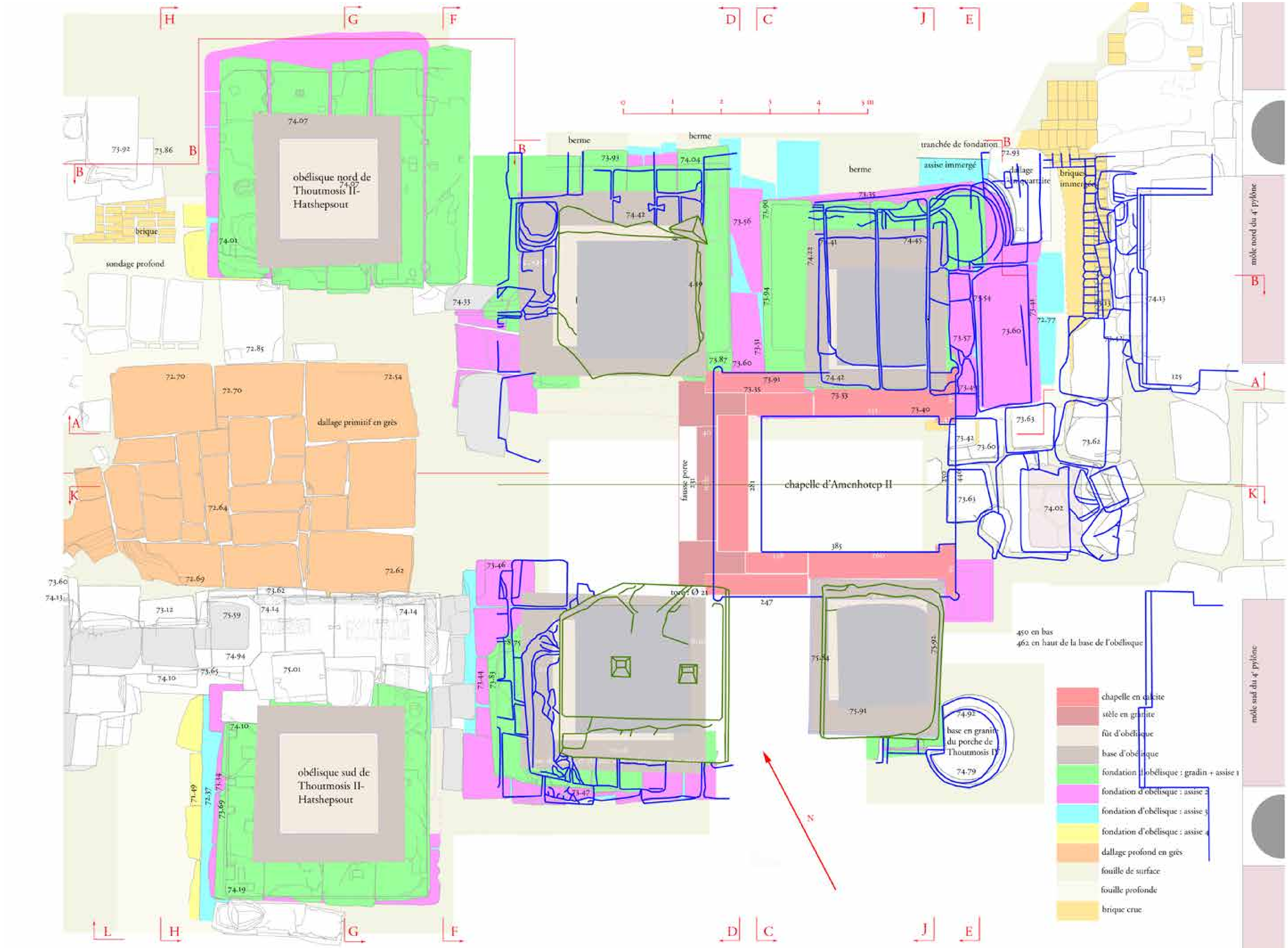
a. La chapelle en calcite d'Amenhotep II entre les obélisques de Thoutmosis Ier   c. Le naos en grès d'Amenhotep II entre les colosses osiriaques du chemisage de l'obélisque sud d'Hatshepsout   f. Sommet de la décoration de la face ouest intérieure du mur est du naos

Pl. 19a. Plan inexact de la chapelle d'Amenhotep II encastrée entre les obélisques de Thoutmosis I[er] devant le 4[e] pylône.
(d'après Gabolde (2012), p. 474, figs. 12 et 13)

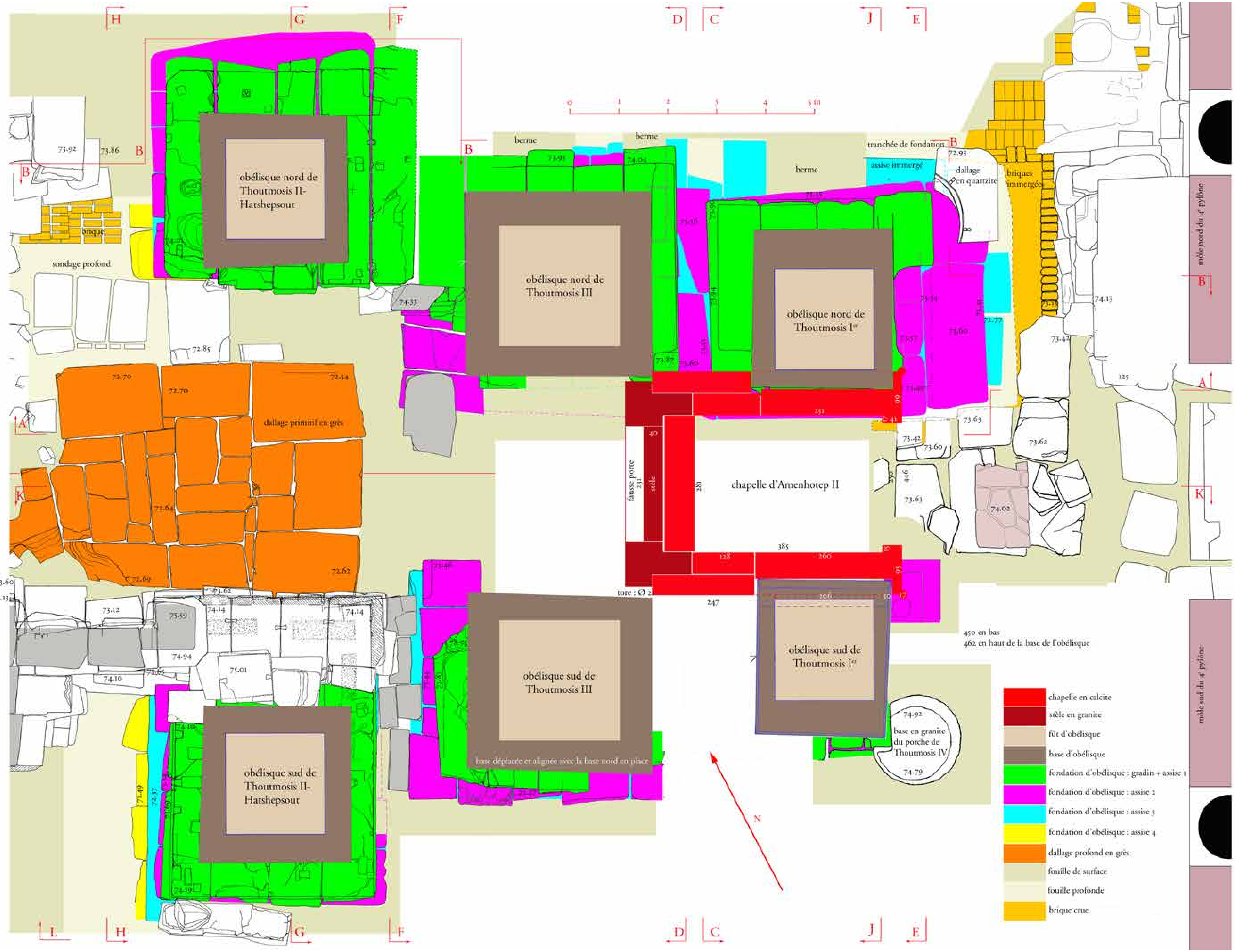




Pl. 19b. Plan inexact de la chapelle d'Amenhotep II superposé à celui des fouilles des fondations des obélisques devant le 4e pylône.

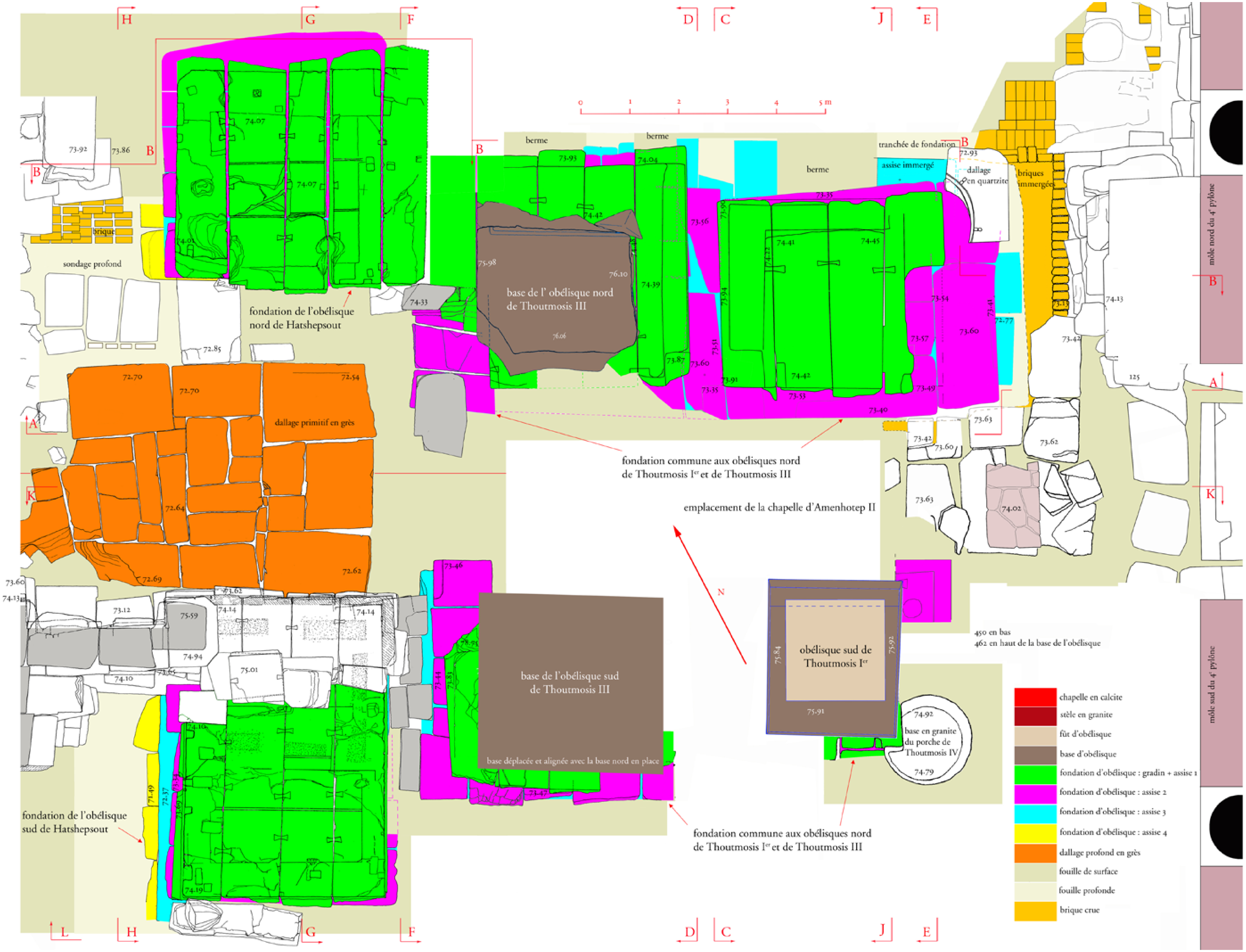


Pl. 19c. Plan de la chapelle d'Amenhotep II encastrée entre les obélisques de Thoutmosis Ier devant le 4e pylône.

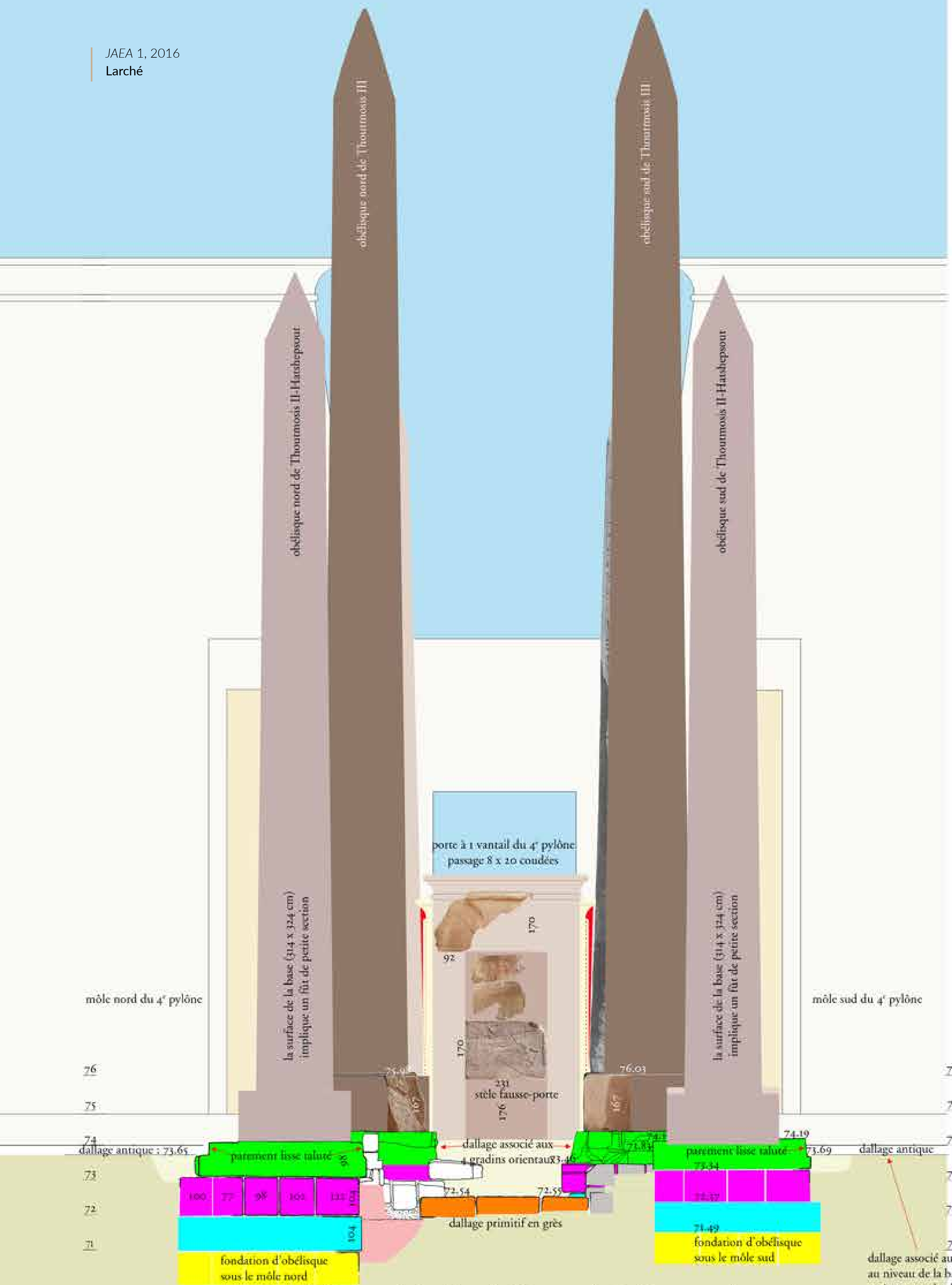


Pl. 19d. Plan des fondations des obélisques restitués devant le 4e pylône.

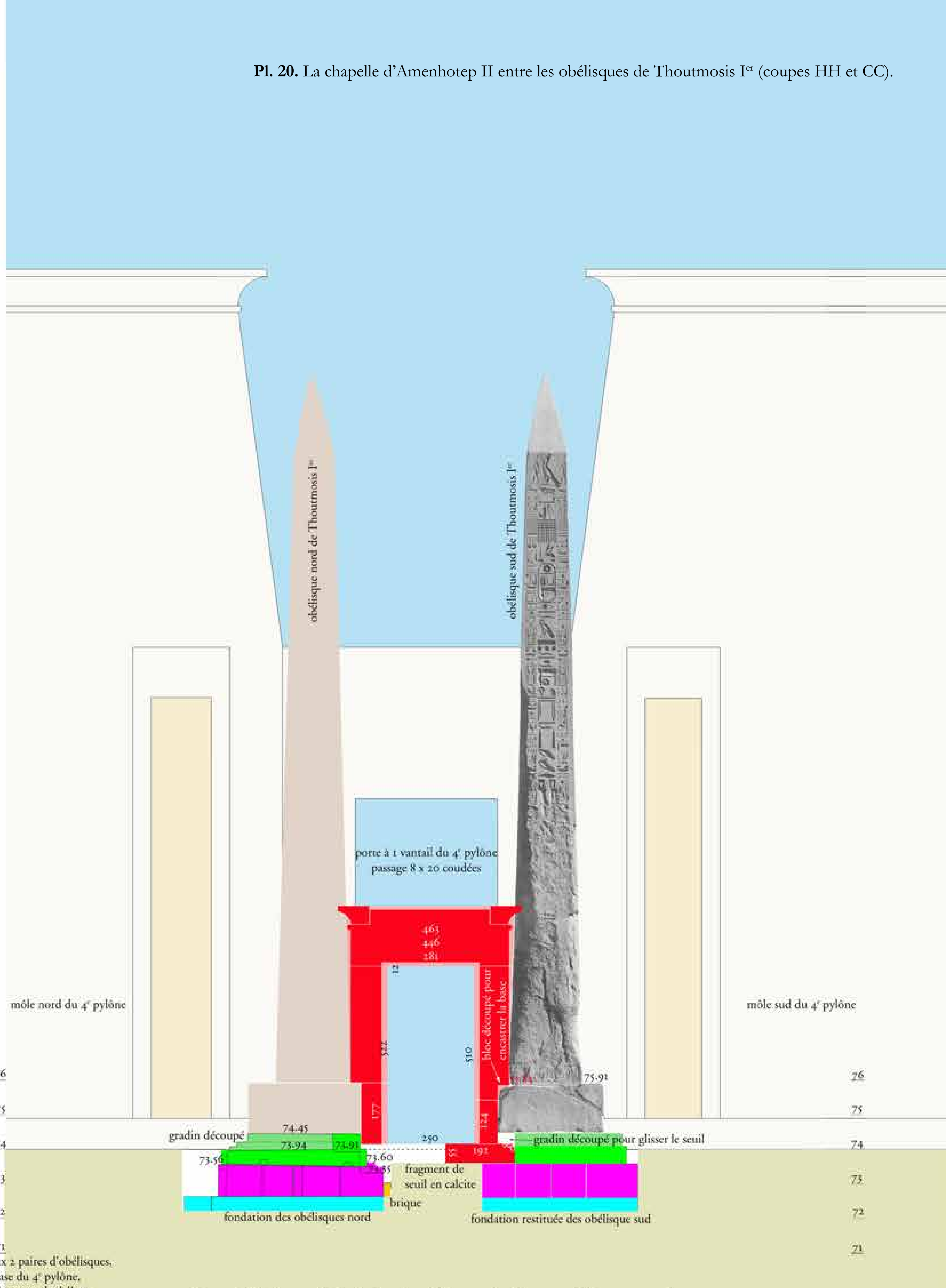
Pl. 19e. Plan des fondations des obélisques devant le 4e pylône.



Pl. 20. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis I^er^ (coupes HH et CC).

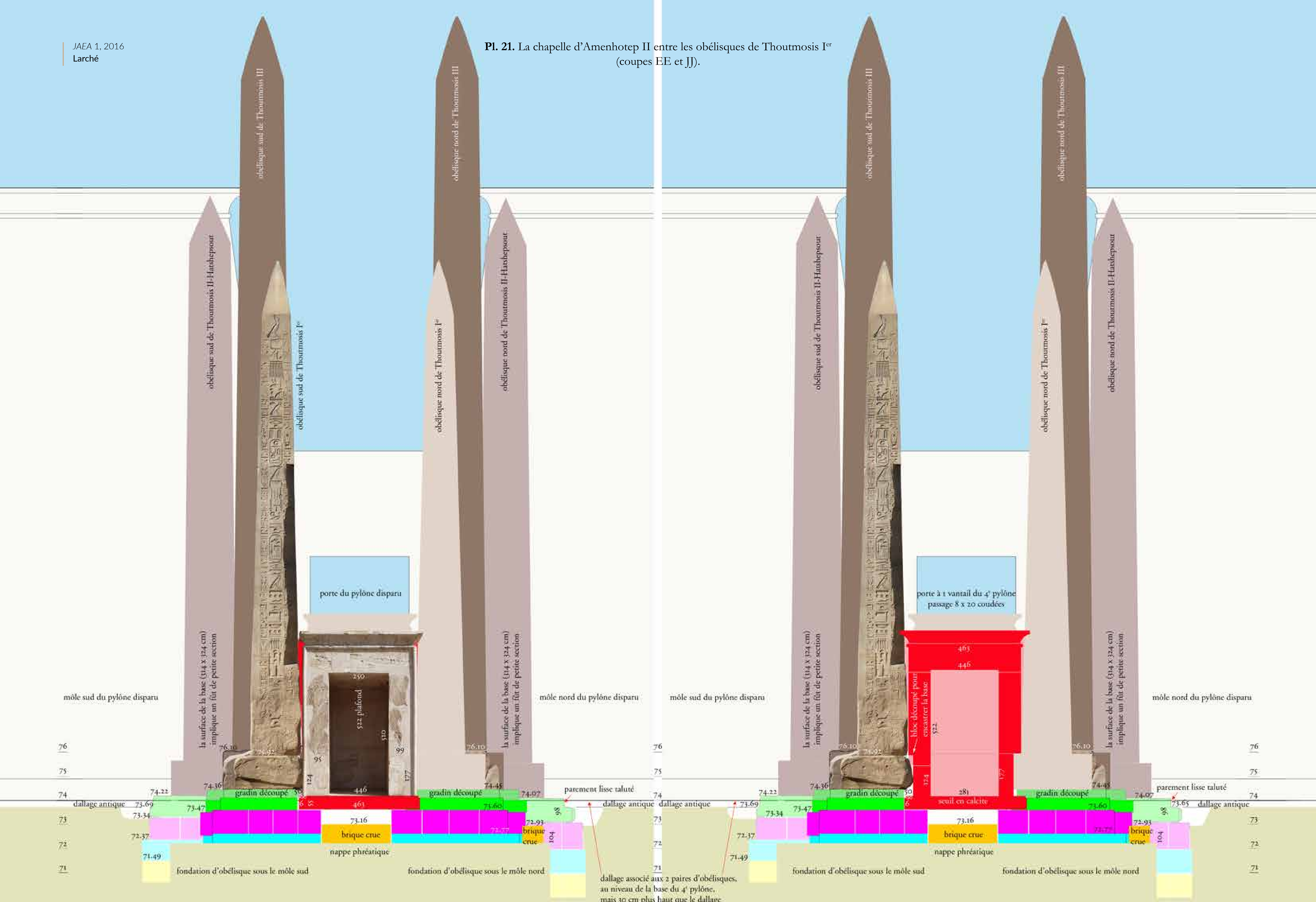


1. Coupe HH à l'ouest des fondations d'obélisques sous le 3e pylône : vue vers l'est



2. Coupe CC à l'ouest de fondations des obélisques de Thoutmosis I^er^ : vue vers l'est

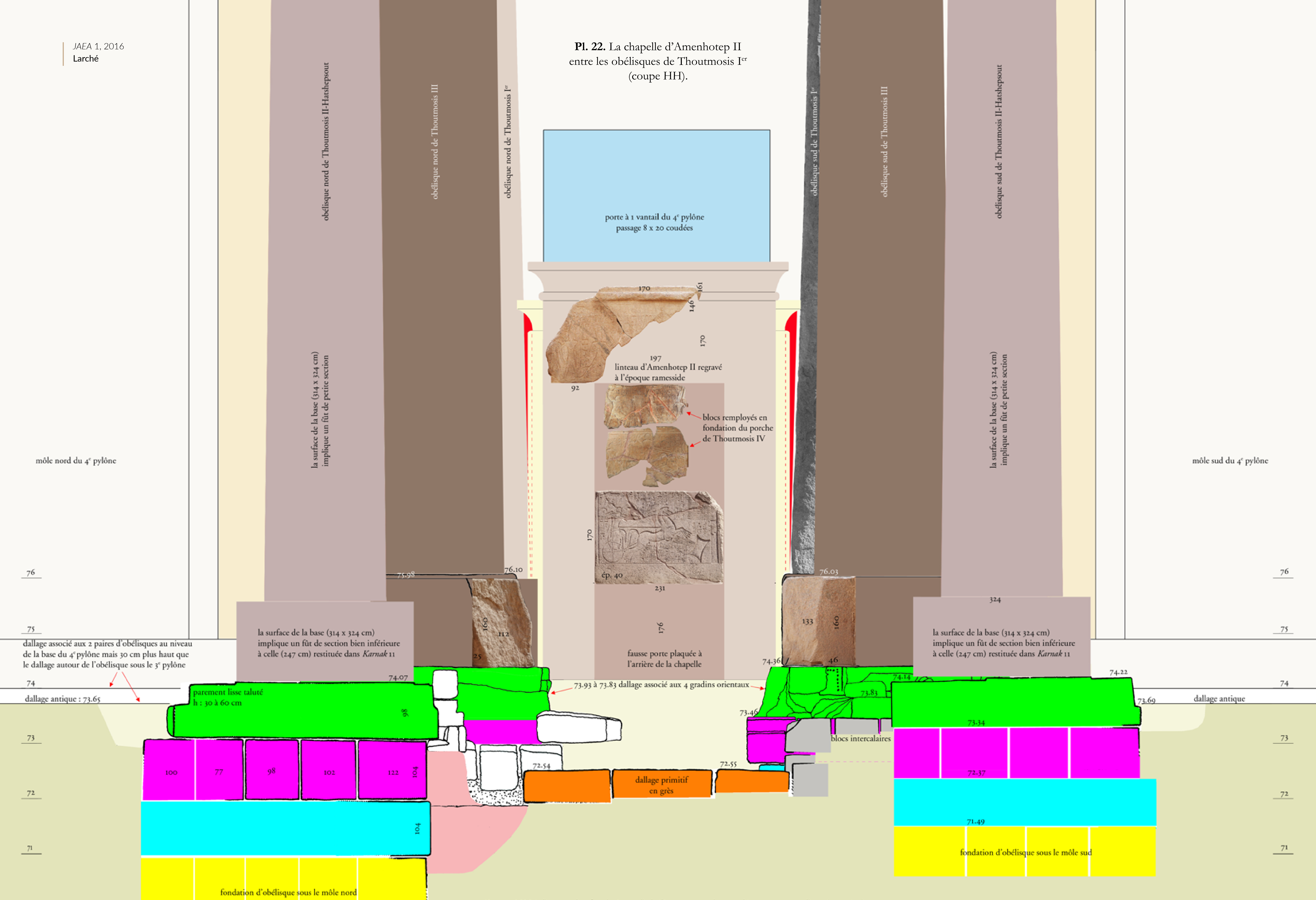
Pl. 21. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupes EE et JJ).



a. Coupe EE devant la façade est de la chapelle d'Amenhotep II : vue vers l'ouest

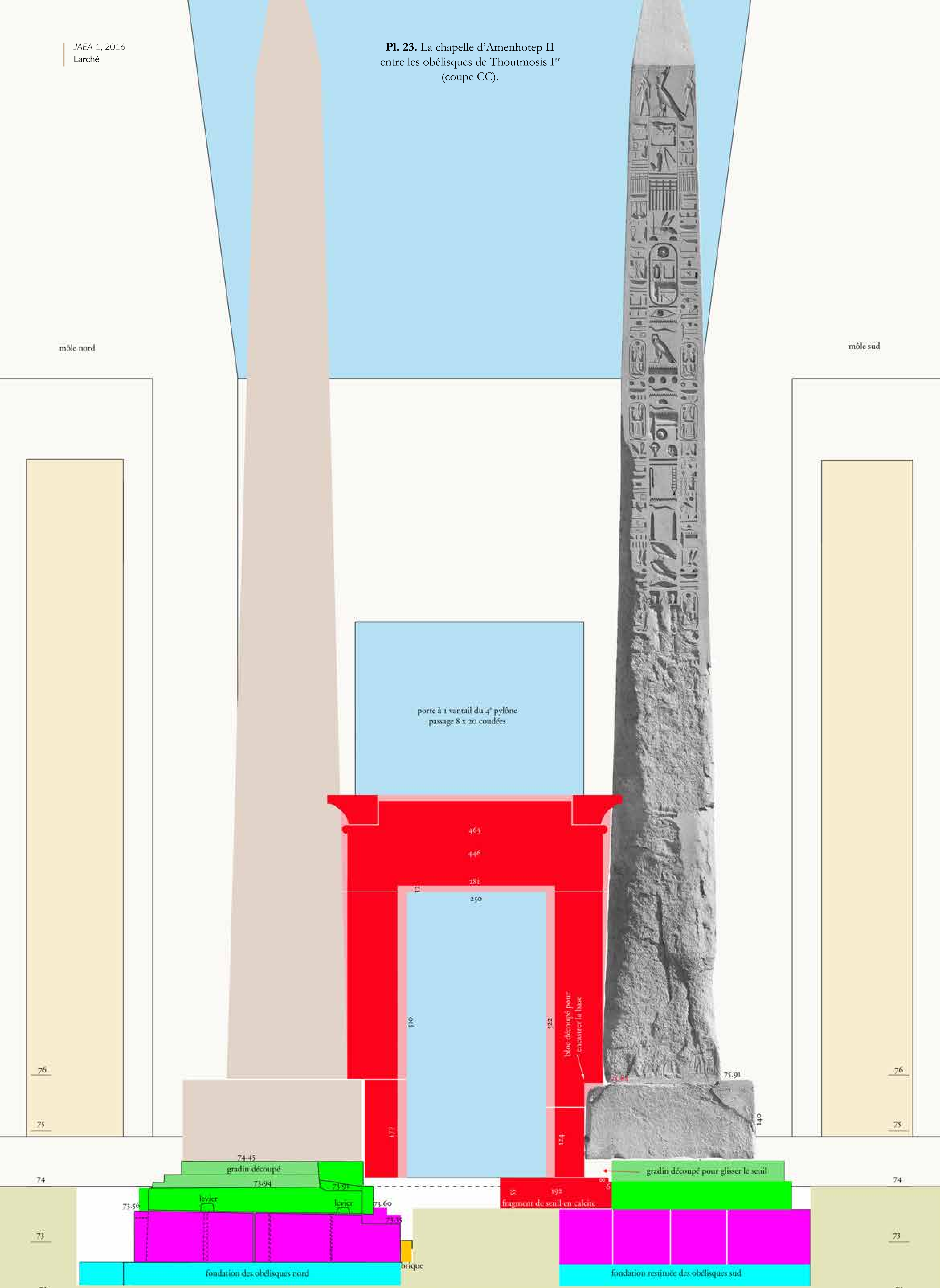
b. Coupe JJ derrière la façade est de la chapelle d'Amenhotep II : vue vers l'ouest

Pl. 22. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe HH).



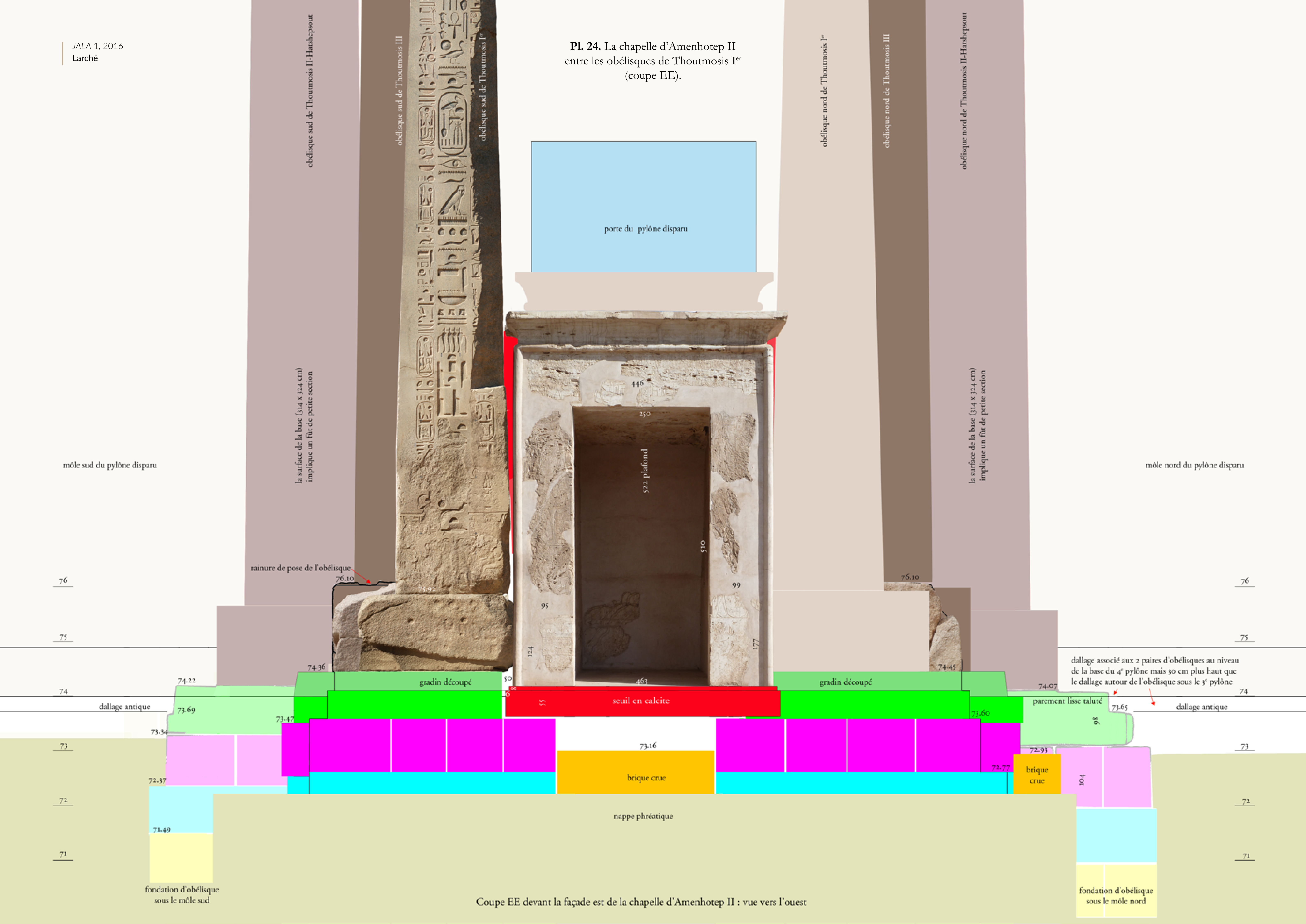
Coupe HH à l'ouest des fondations d'obélisques sous le 3e pylône : vue vers l'est (2 cm/m)

Pl. 23. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe CC).



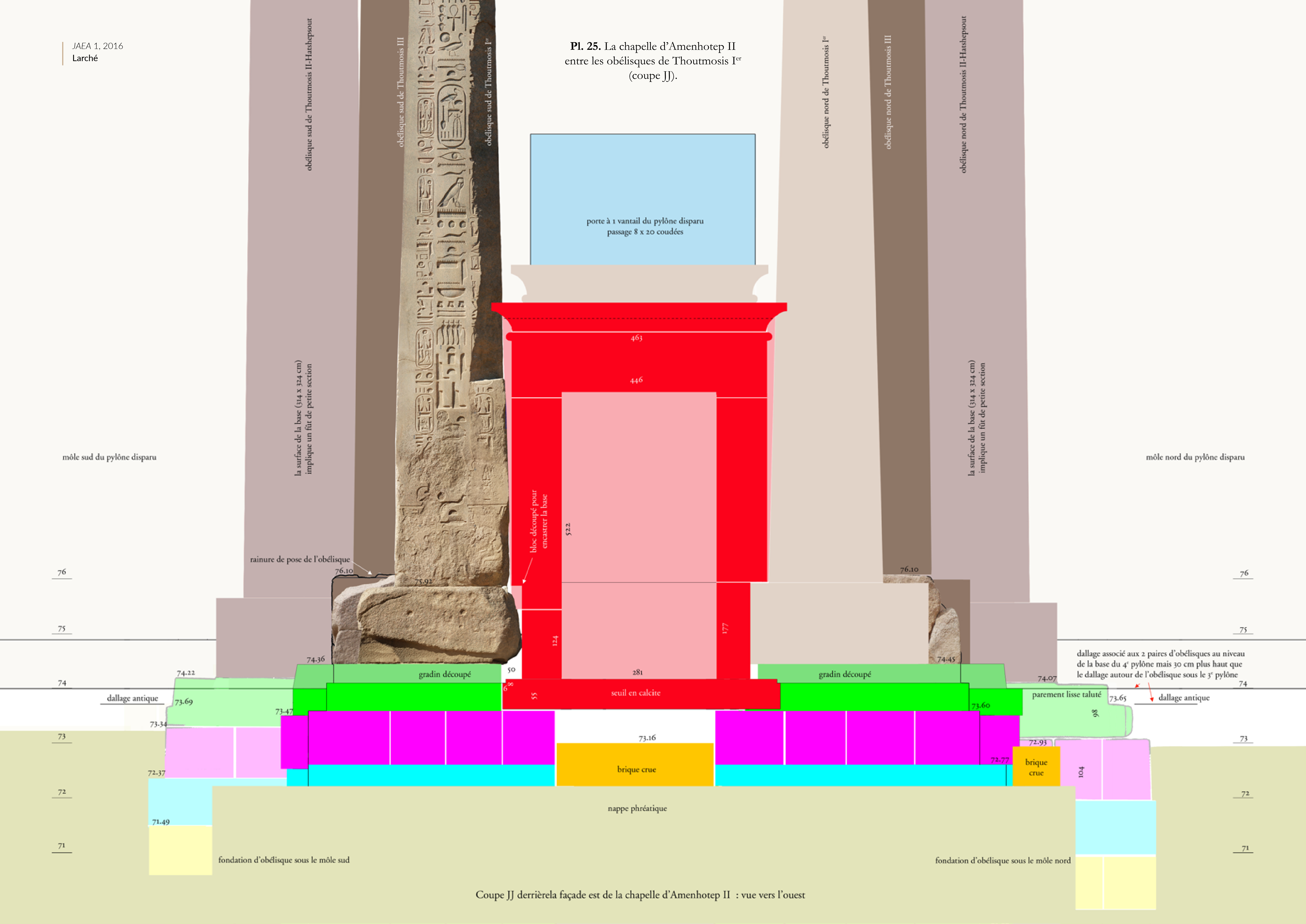
Coupe CC à l'ouest de fondations des obélisques de Thoutmosis Ier : vue vers l'est (2 cm/m)

Pl. 24. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe EE).

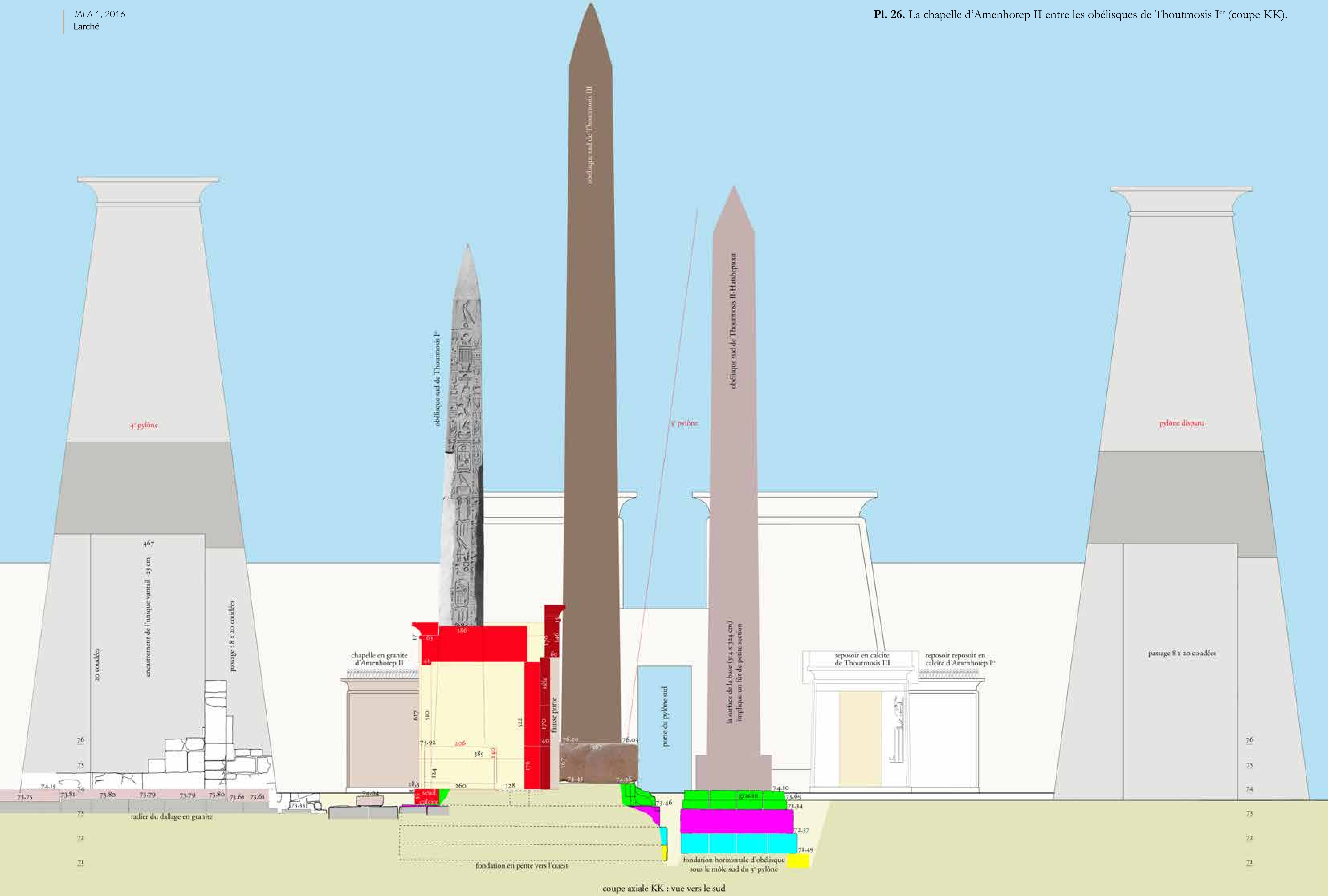


Coupe EE devant la façade est de la chapelle d'Amenhotep II : vue vers l'ouest

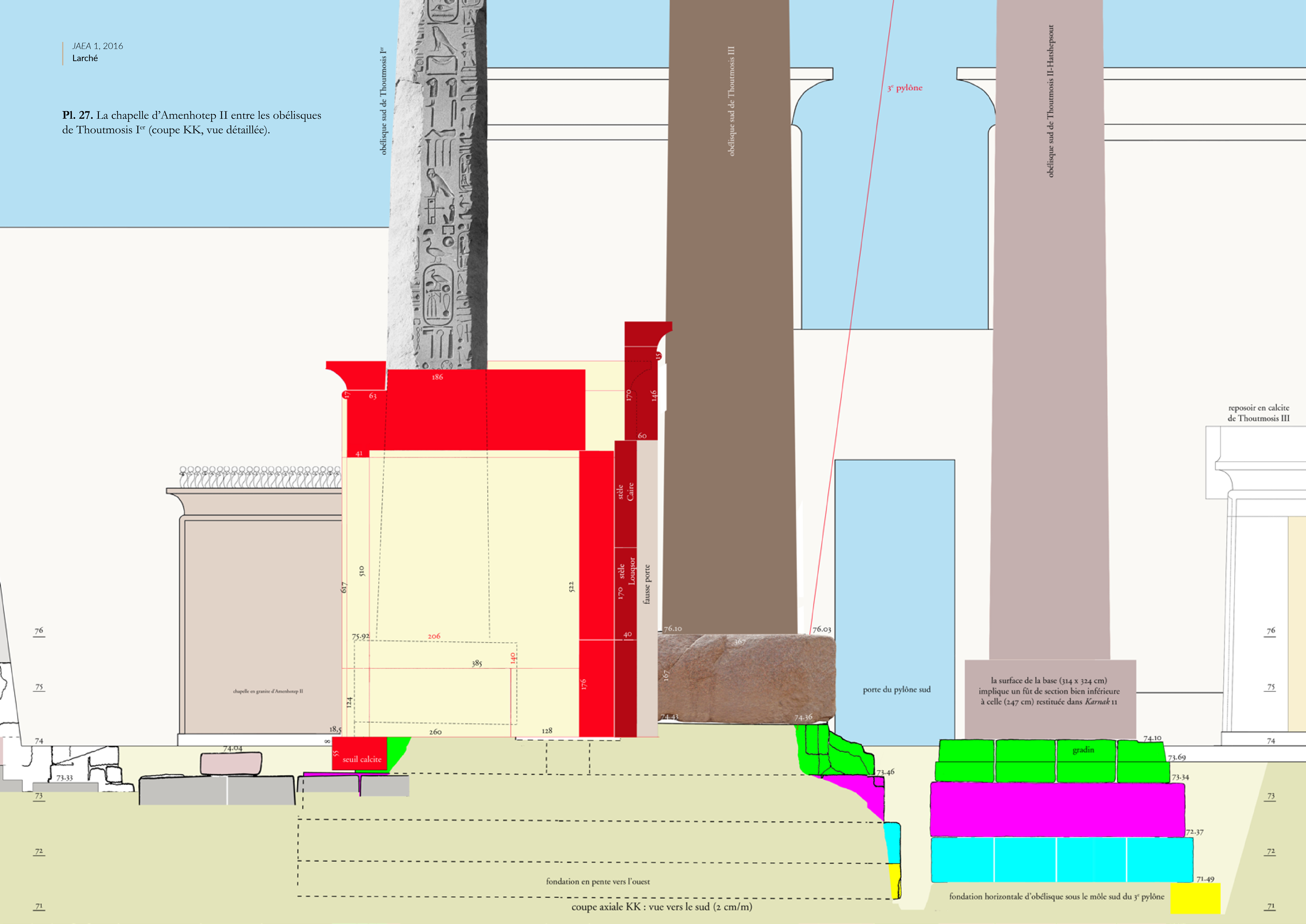
Pl. 25. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe JJ).



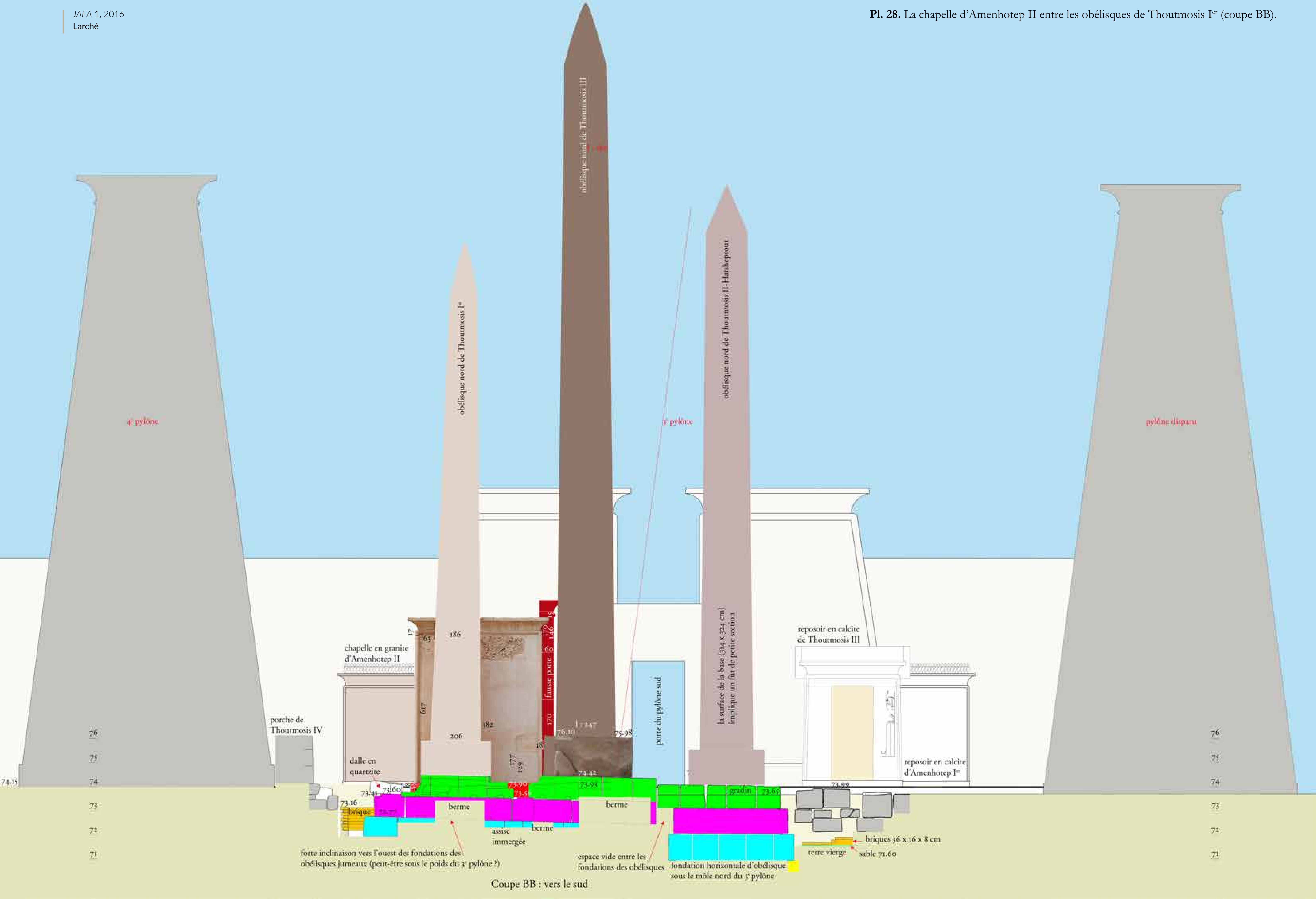
Pl. 26. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe KK).



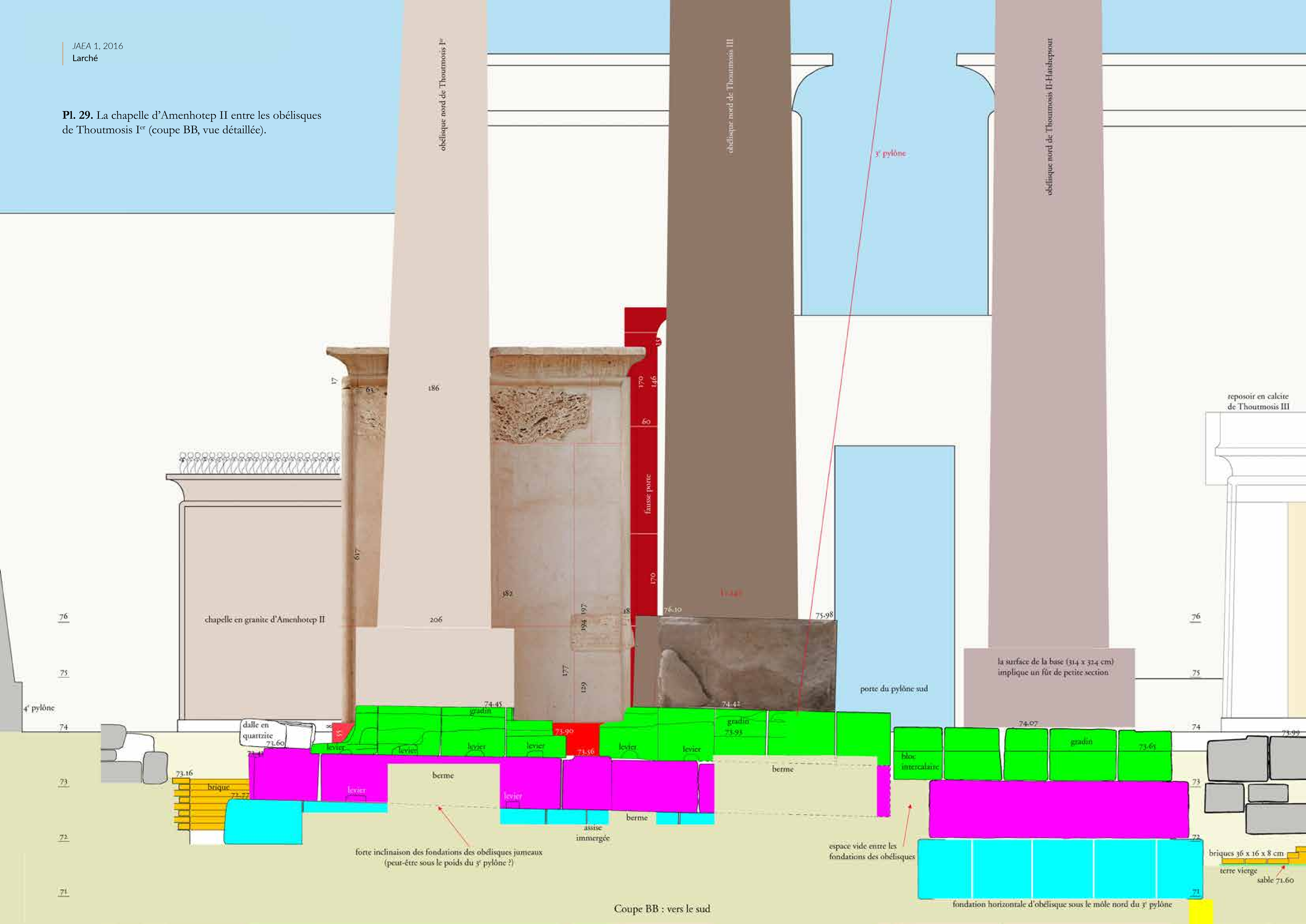
Pl. 27. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis I[er] (coupe KK, vue détaillée).



Pl. 28. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe BB).

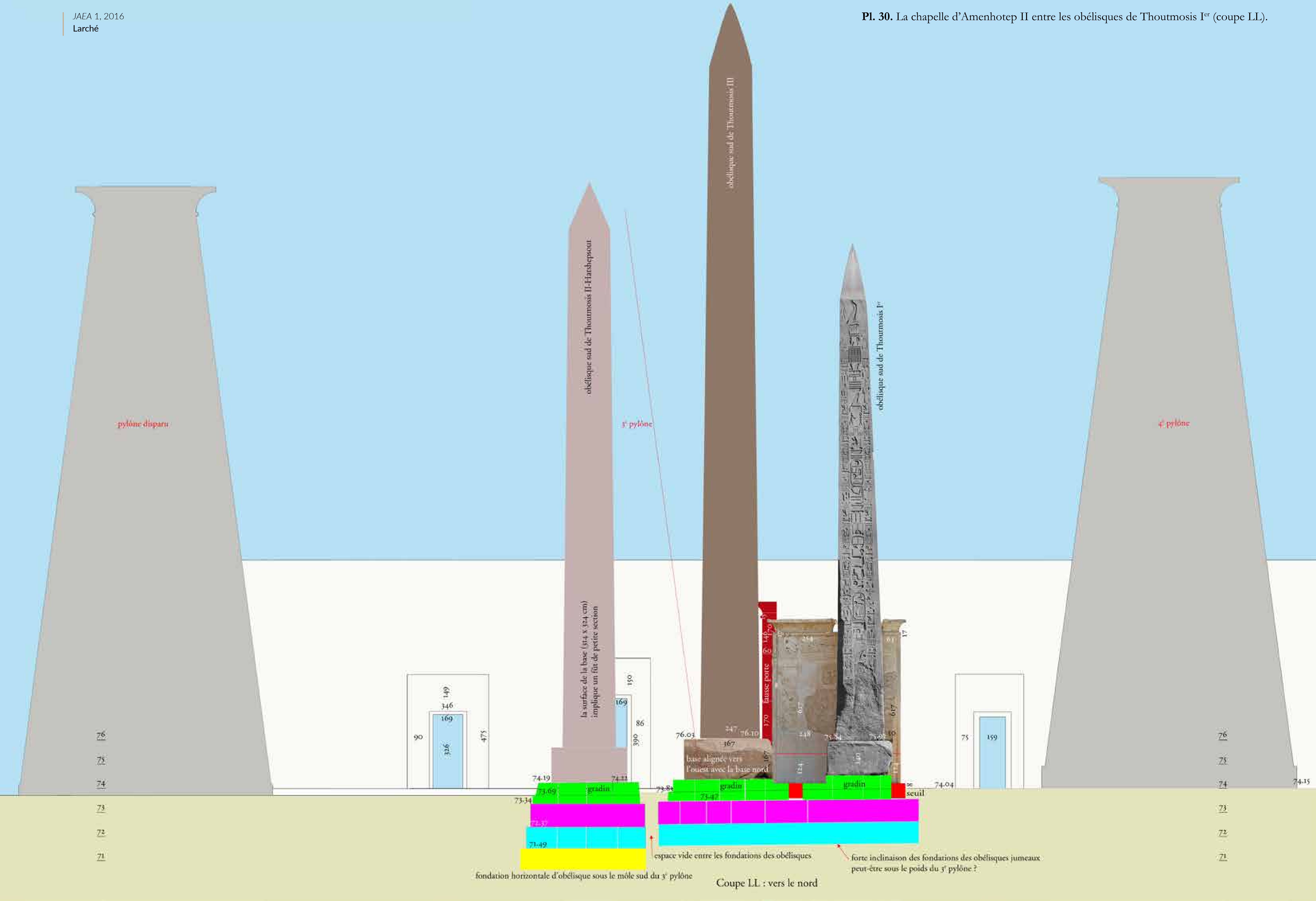


Pl. 29. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe BB, vue détaillée).

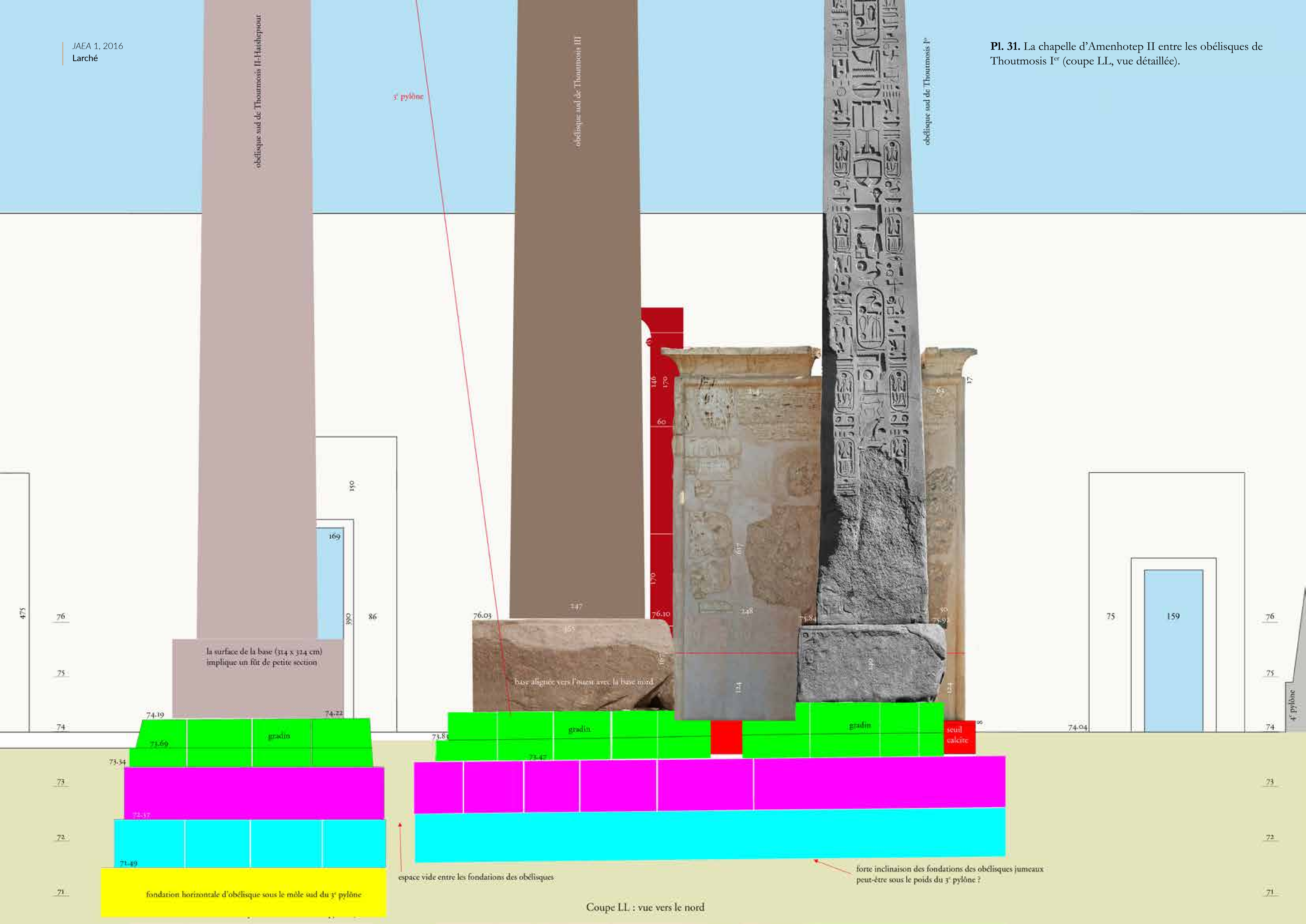


Coupe BB : vers le sud

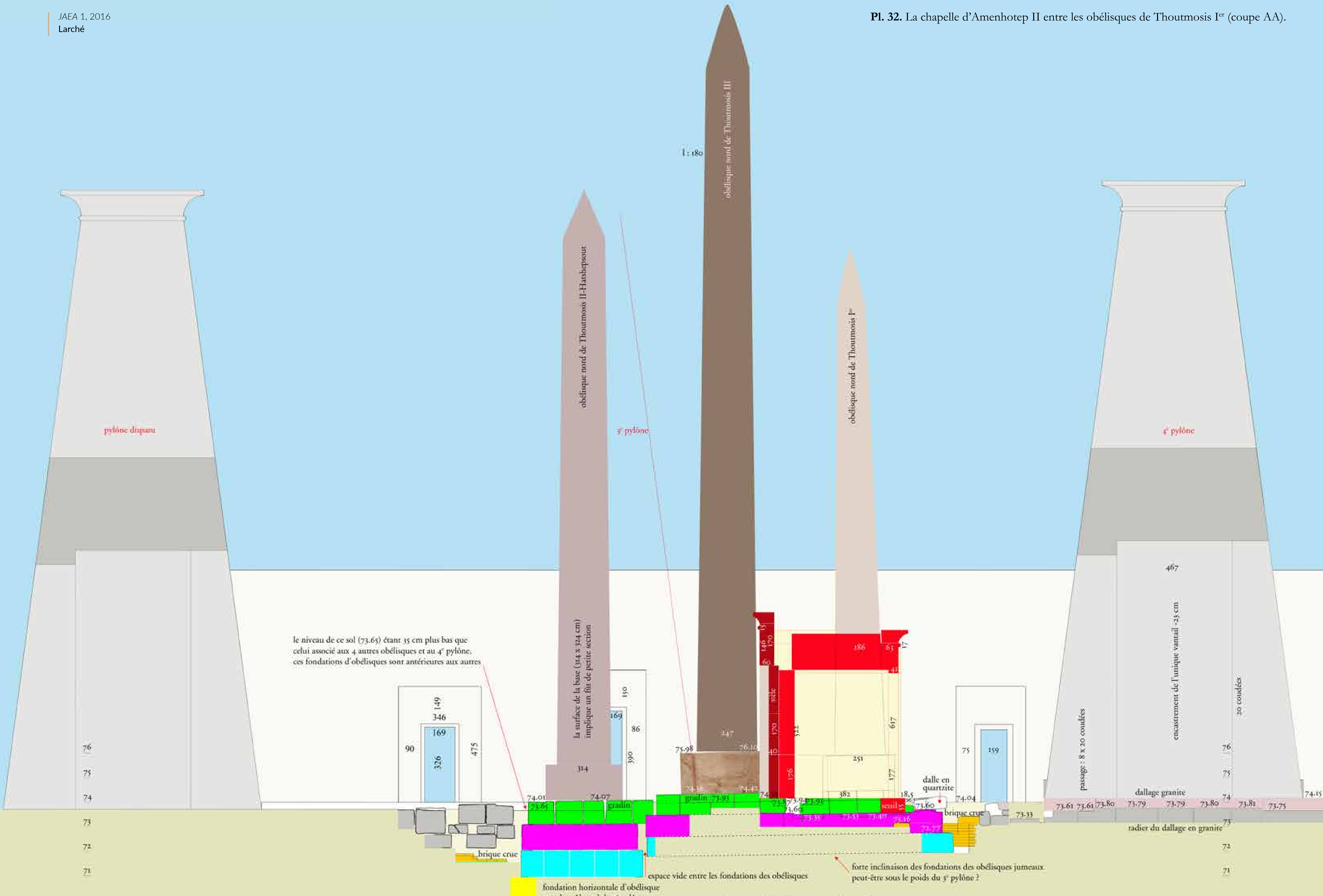
Pl. 30. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe LL).



Pl. 31. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe LL, vue détaillée).

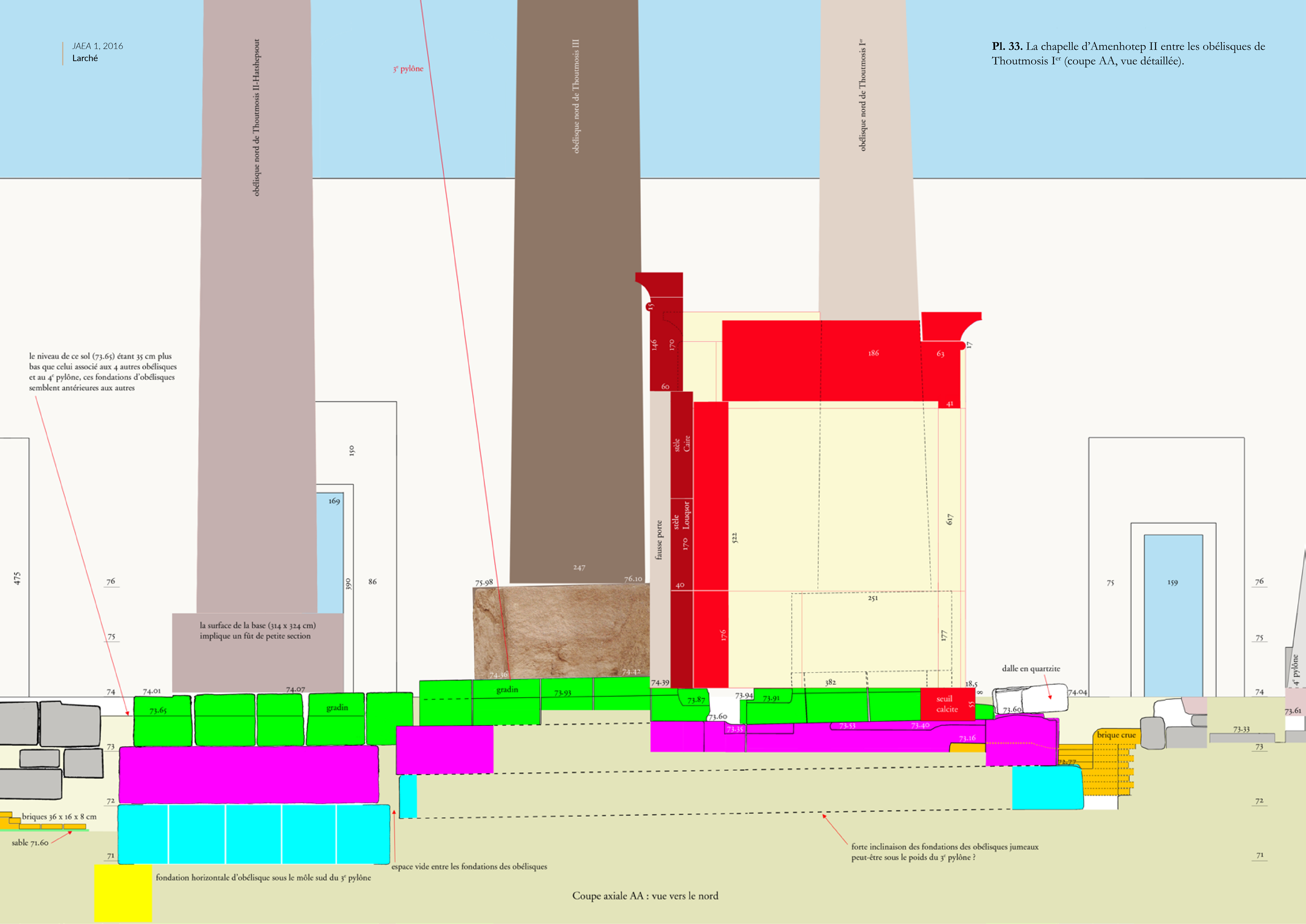


Pl. 32. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe AA).

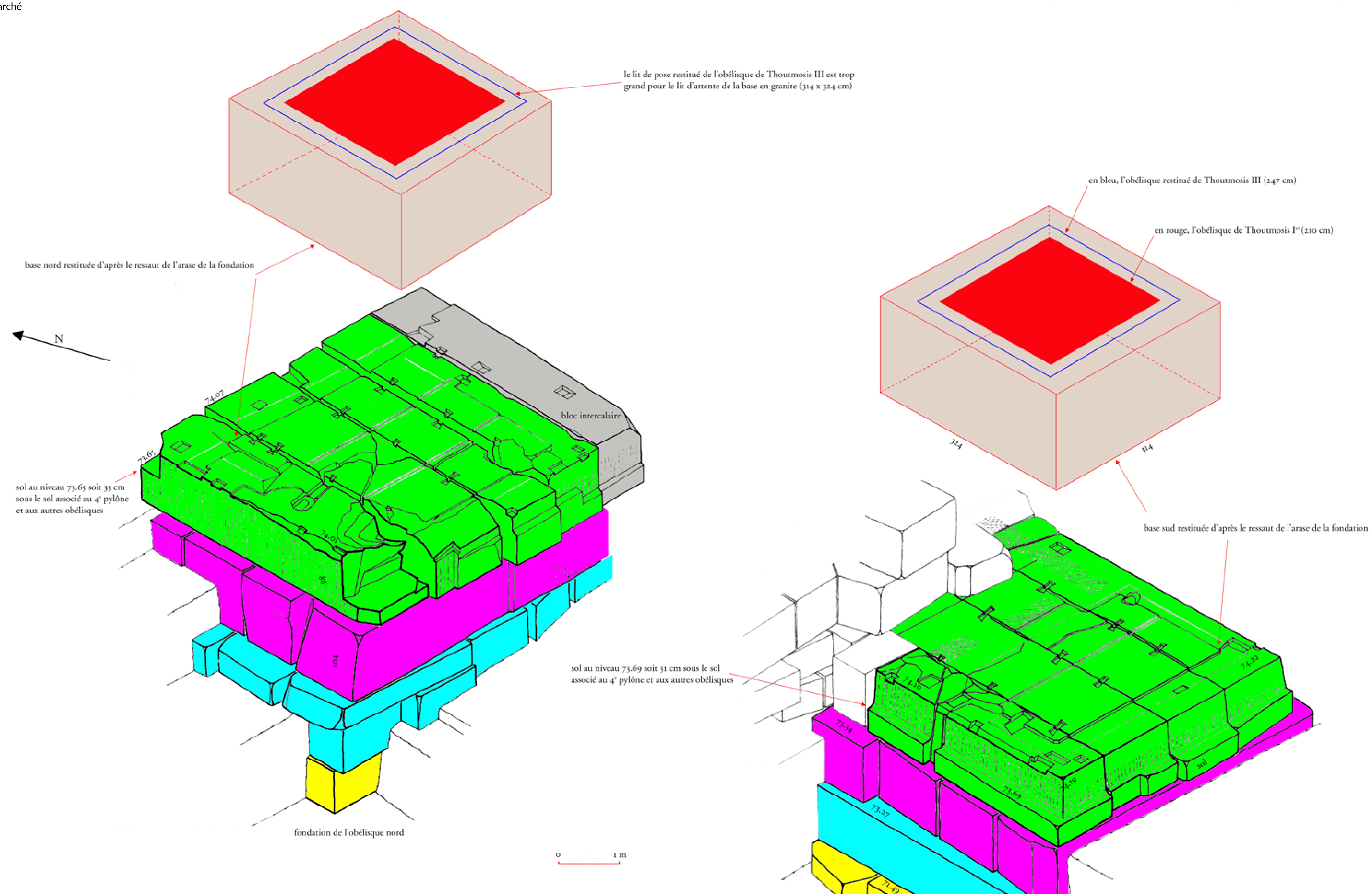


Coupe axiale AA : vue vers le nord

Pl. 33. La chapelle d'Amenhotep II entre les obélisques de Thoutmosis Ier (coupe AA, vue détaillée).

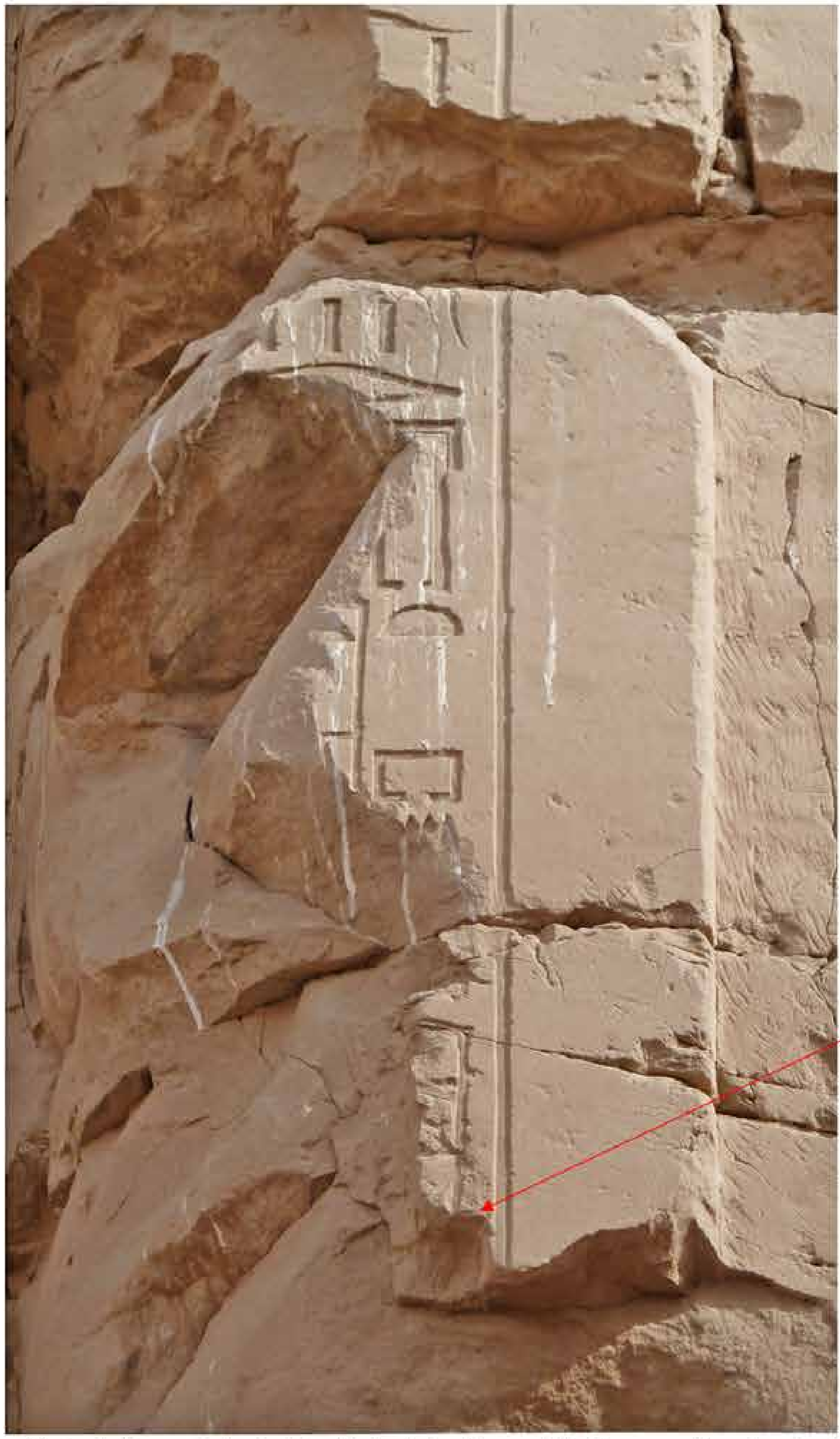


Pl. 34. Les fondations des obélisques de Maâtkarê (Thoutmosis II), phase a, sous le 3e pylône.

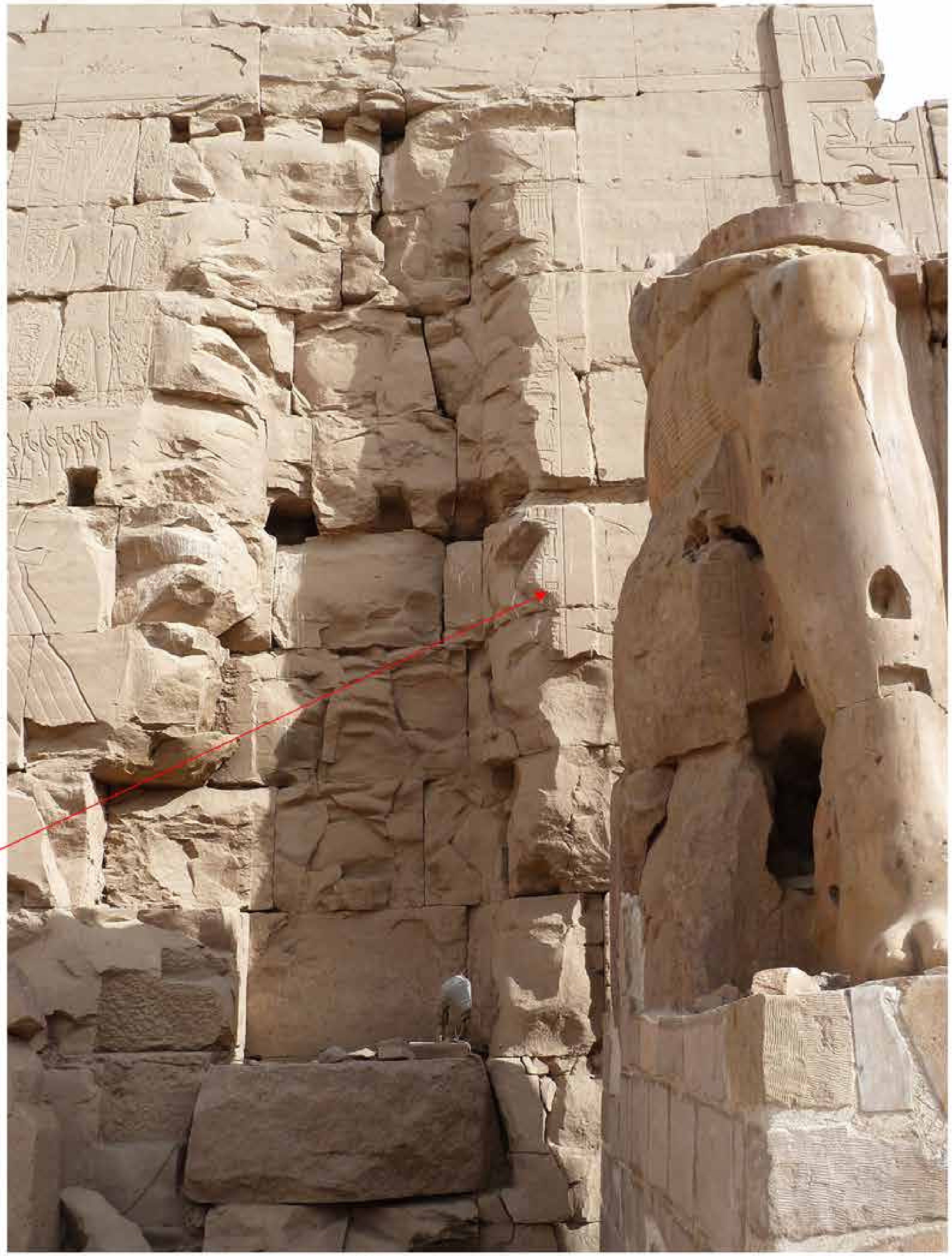


Vue axonométrique du sud-ouest vers le nord-est (2 cm/m)
d'après S. Sauneron, *Kêmi* 19, p. 266, fig. 14

Pl. 35. Les niches de mâts du 8e pylône décorées par Amenhotep II.

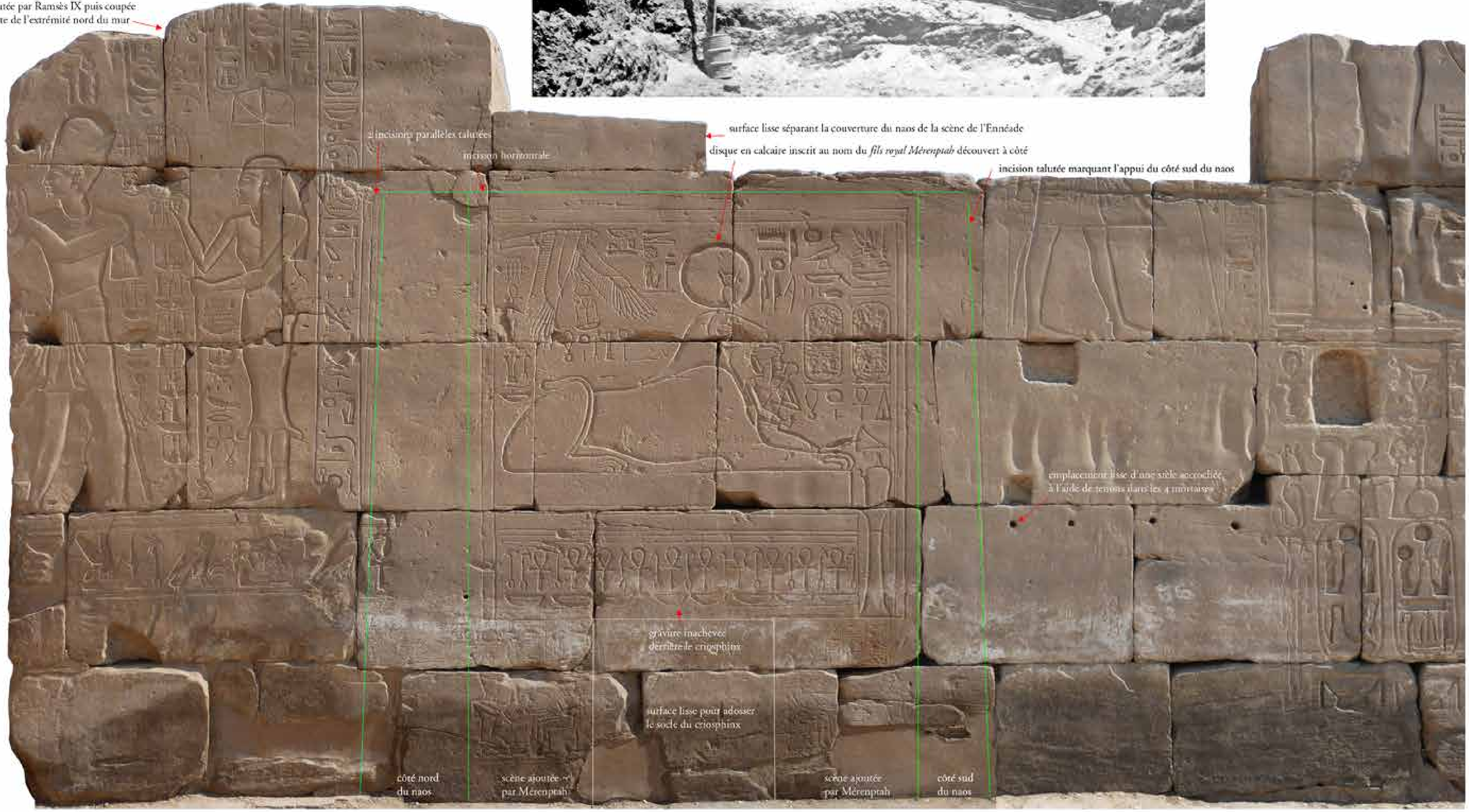


a. Mention de *Rw-ty* sur le chambranle de niche de mât du môle ouest du 8e pylône et sur celui remployé dans le môle nord du 5e pylône ainsi que sur la grande porte sud d'Amenhotep Ier et sur l'obélisque sud de Thoutmosis Ier



b. Niche de mât du môle ouest du 8e pylône

Pl. 36. L'impossible appui de la chapelle d'Amenhotep II.



Ayant encore la tresse des enfants, le jeune roi dont les cartouches ont été usurpés par Merenptah est agenouillé entre les pattes d'un criosphinx. Cette partie du parement semble regravée sur une décoration plus ancienne.