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MUD-BRICK
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Virginia L. Emery

Lehmziegel
Brique crue

Made from a mixture of silt, clay, sand, and straw formed into regular molded units, unfired mud-bricks were the primary construction material employed in ancient Egypt—being quite literally the most basic of building blocks for all levels of domestic structures, from simple one-room buildings to lavishly decorated palace complexes, as well as administrative and storage structures, and even early phases of temples. Modern methods of mud-brick fabrication accord with ancient evidence, suggesting that the production of unfired mud-brick has remained a stable technology through the millennia. Ancient evidence concerning mud-brick not only illuminates mud-brick production organization, but also highlights the symbolic significance of bricks in religious contexts, especially relating to birth and death.

صنع الطوب اللبن (الآجر) من مزيج من الطمي، الطين، الرمل والقش (التبن)، وتم تشكيله كوحدات باستخدام القوالب. وكان الطوب اللبن هو مادة البناء الاساسية بمصر القديم ويمكن القول أنه كان هو أساس كل البنايات السكنية بدءاً من مباني بسيطة ذات حجرة واحدة وحتى مباني القصور الفارهة والمزينة، بالإضافة إلى مباني إدارية وبنايات للتخزين وحتى المراحل الأولى من تشييد المعابد. تتطابق صناعة الطوب اللبن الحديثة مع الأدلة الأثرية، مشيرةً إلى أن صناعة الطوب اللبن ظلت ثابتة طوال آلاف السنين. أن الأدلة الأثرية المتعلقة بالطوب اللبن لا توضح فقط تنظيم إنتاج الطوب اللبن، ولكنها تبرز أيضاً أهمية الطوب في السياقات الدينية خاصةً المتعلقة بالولادة والوفاة.

Adobe, a building material of mixed earth and straw, is commonly employed in arid environments as the standard construction material. In fact, the word adobe can be traced back to the ancient Egyptian word for brick, *ḏbt*; *ḏbt* became Coptic ⲧⲱⲃⲉ, which entered into Arabic as طوب (*toob*), which probably eventually reached Spanish as *adobe* (Kemp 2000: 80; Mond and Myers 1934: 48, note 2). Within Egyptology, these sun-dried building blocks traditionally have been identified as mud-bricks, rather than as adobe, although they increasingly are being labeled as unfired brick, in an effort to shift away from what is perceived as a Nilocentric perspective focused on bricks fabricated with riverine sediment to a more inclusive term that explicitly includes bricks made with desert sands and marls as well.

Most ancient Egyptian constructions employed unfired mud-brick as the primary building material. At the beginning of the famous biblical story of the Exodus, the enslaved Israelites were forced to make mud-bricks for the Egyptians (Exodus 1:11 - 14), a task made even more arduous when pharaoh rescinded their supplied straw source (Exodus 5:1 - 21), insisting that they gather their own or (famously) make bricks without straw,

which subsequently came to be a metaphor for accomplishing the impossible (for the question of bricks made without straw in ancient Egypt, see Nims 1950: 21 - 28). Unfired mud-brick was the most common building material used in ancient Egypt. Even though standing stone monuments are the stereotype for ancient Egyptian building endeavors, the vast majority of buildings in Egypt, including subsidiary temple buildings (and sometimes early phases of temples themselves), royal palaces, and funerary monuments, employed mud-brick construction. Due to its prevalent use, unfired brick has the potential to inform upon the cultural customs and organization of the ancient Egyptians, though it is currently a little-used archaeological resource, both culturally and scientifically.

The Manufacture of Mud-Brick

1. Ingredients. Unfired mud-brick is still made throughout the world today, and various methods are used in its manufacture, ranging from large-scale production using a bulldozer and grids of brick molds in the southwestern United States to small-scale production with an adze or hoe and a single-brick mold for individual construction jobs in villages in Egypt. Though the scale differs, the materials used to make the bricks are relatively consistent: a mix of sand, clay, and silt combined with chopped straw or dung as temper and binding agent (French 1984: 192 - 196; Kemp 2000: 79 - 83; McHenry 1989: 48; Morgenstein and Redmount 1998: 129 - 130; for an account of brick production in the Classical world, see Vitruvius Pollio 1960: 42 - 44). If the earth mixture has a high enough percentage of clay, the straw is not always necessary; omitting the straw can reduce the chance of insects eating through the organic content of the bricks, thereby weakening them (Clarke and Engelbach 1930: 208 - 209; Nims 1950: 26; Oates 1990: 388). However, untempered bricks with a high percentage of clay can dry slowly, shrink, crack, and lose their shape (Lucas 1962: 49; Morgenstein and Redmount 1998: 129; Nims 1950: 24). The ratio of sand to clay to silt varies in the surrounding environment from place to place, but the mix that creates the best bricks, a mix containing no more than thirty percent clay or silt and no less than fifty percent sand, is standard and can be artificially produced (Hohn 2003: 1; Kemp 2000: 80). In Egypt, alluvial Nile sediment was and is traditionally employed, with desert sand added to create a mixture in the ideal range; occasionally, marl clays could be used as well, depending on the local environment and available resources (Fathy 1989: 198 - 199; Kemp 2000: 79 - 84; Morgenstein and Redmount 1998: 129). Specifically, alluvial sediment removed from the plow-zones of worked fields is a preferred source of material with which to make mud-bricks (Kemp 2000: 80), as is the sediment cast up when canals are dredged (Fathy 1989: 154); both are sources from which matrix with well-mixed particle sizes can easily be obtained, thereby minimizing the need for processing before adding sand or organic temper.

2. Production. To make bricks, sediment is removed from its source, dumped in a circular area (Arabic *makhmara*) created for the job, broken up with adzes or hoes, and mixed with water to form a stiff mixture. Chopped straw is then added to the earth mixture in a ratio of roughly one part straw to five parts earth. Straw in Egypt today is sold by the *hamla* or *himl*, a measure of 555 pounds, which is theoretically what a donkey can haul in its baskets (Fathy 1989: 198 - 199; Henein 1988: 38), and therefore proportions in modern Egyptian mud-brick recipes usually are expressed by volume rather than by weight (Henein 1988: 40, note 1). In ancient Egypt, the donkey load for straw was a known measurement expressed as *ꜥꜣt* ("donkey load"; see Janssen 1975: 448). The straw is kneaded into the earth mixture with hands or by treading, and the whole concoction is left to age and ferment for a night or two (Fathy 1989: 200; Henein 1988: 38; Morgenstein and Redmount 1998: 130; Nims 1950: 26). The following day, the earth-straw mixture is re-kneaded and more water is added, at which point the mixture is ready to mold (Henein 1988: 38 - 39).

Figure 1. Unmolding new mud-brick.

Although double molds for making two bricks at a time are sometimes used in the southwestern United States (Hohn 2003: 1), Egyptians universally tend to employ single molds. Egyptian molds are simple rectangles made of wood, with one end of a long side extended to create a handle. The earth-straw mixture is carried in flat, round baskets from the preparation area, the *makhmara*, to a brick field that has been strewn with straw to prevent the molded bricks from adhering to the ground surface while drying. The wooden mold is quickly dipped in water to prevent the earth-straw mixture from sticking to it during the molding process, then filled to slightly over capacity with the earth-straw mixture, which is compacted and flattened out. The mold is then carefully removed, without jostling the form of the newly-made brick, and the process is repeated (fig. 1; Henein 1988: 38 - 39; Nims 1950: 26 - 27). Bricks are lined up with the thickness of the mold's edges between them (Spencer 1979: 3) and left to dry for three days before being turned over and left to dry for another three days (Fathy 1989: 200). After six days, the sun-dried bricks are piled on their sides and left to continue drying, the longer the better (fig. 2). Thus, the total number of days needed to produce usable bricks varies depending on personal idiosyncrasies in technique, but eight or nine days from beginning to stacking seems to be average. Bricks that have been dried longer are preferred and thus require even further planning; for construction in the fall, bricks could be made in the spring and left to dry all summer (Morgenstein and Redmount 1998: 130).

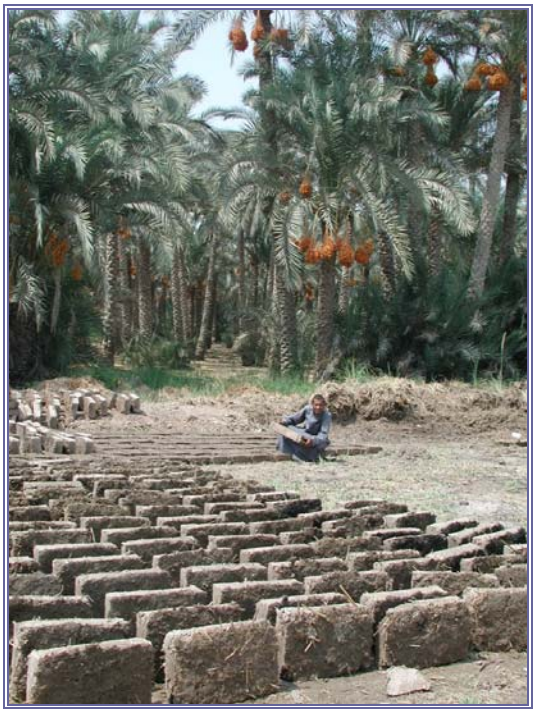

Figure 2. Striking new mud-brick. Note the earth-straw mixture in the background and brick turned for drying in the foreground.

While the style of wooden brick molds employed to produce bricks was standard in ancient Egypt, the size of the molds, and therefore of the bricks themselves, was not standardized, and ancient bricks ranged greatly in size. Based on the recorded archaeological evidence, for ancient Egypt, there is a general trend for smaller bricks in the earlier periods, with average brick size increasing through the Middle Kingdom, New Kingdom, and Late Period, and a subsequent size reduction in the Ptolemaic, Roman, and Coptic Periods (Spencer 1979: 147 - 148 and pls. 41 – 43; for a less nuanced perspective, see Jéquier 1924: 14 - 15), a trend attested elsewhere in the ancient Near East (van Beek and van Beek 2008: 258 – 264, and 272 for the difficulty of dating construction based on the sizes of the bricks). However, this trend is only broadly true for Egypt and ought not be taken as ultimately chronologically diagnostic, because, in addition to the consideration of

brick sizes through time, differences in size based on the type of construction and on the sponsoring agent of that construction also apparently affected brick formats. Constructions initiated by private individuals in domestic contexts produced and employed smaller bricks than "public" constructions undertaken by governmental or sacerdotal institutional entities—a size difference presumably reflecting the use of two different cubit lengths, that of the standard cubit and that of the royal cubit (Spencer 1979: 147 - 150). However, brick size cannot be applied indiscriminately as a means by which to draw conclusions with regard to the function of a structure or to those who initiated its construction, as the re-use of old mud-bricks in new constructions was common practice, being particularly clearly attested on the Theban west bank, where the large, stamped mud-bricks of the various royal funerary complexes increasingly were reemployed in domestic contexts (for a summary of this phenomenon, see Spencer 1979: 144). Although brick sizes are not solely sufficient to determine clearly either the date of construction or the function of a structure, a consideration of varying brick sizes within a site may bear information to aid in the relative chronology specific to that site (Mond and Myers 1934: 47 - 52).

3. Modern work organization. In traditional Egyptian villages, knowledge of how to make unfired mud-brick is almost universal (Fathy 1989: 4 - 5; Henein 1988: 38), and knowledge of the proper proportions for the earth-mixture appears to be connected to an intuitive sense of the local environment developed through agricultural work (Kemp 2000: 80). When construction needs arise, each family produces its own bricks, or, if they lack the time and have the monetary resources, they can hire out the production of bricks to others; neighbors frequently help each other on a voluntary basis, with the implicit understanding that when aid is needed in return, it will be offered. For private construction jobs, mud-bricks are made by both men and women, with the women carrying the earth from the source to the *makhmara*, where the men create the earth-straw mixture; women then carry the earth-straw mixture to the brick field, where both men and women work to form the bricks (Henein 1988: 38 - 40, pls. 6a - c). In large-scale, public construction employing unfired brick, the bricks are made by men working in teams of four, with two brick makers for molding, one laborer for mixing, and one laborer for carrying the mortar; three additional laborers are added to these teams to help with the turning and stacking of the bricks as they dry. Any number of such teams can work at the same time, with their labor and their use of raw materials coordinated by a supervisor (Fathy 1989: 199 - 200). Whether for small-scale or large-scale construction, bricks are produced in batches, usually groups of one thousand bricks, and the workers are paid accordingly, rather than receiving a daily wage (Fathy 1989: 198 - 213; Henein 1988: 39 - 40). Just as the method of the production of unfired brick is not specialized knowledge, so too are methods of construction with mud-brick generally non-specialized (Fathy 1989: 4 - 8; Henein 1988: 39 - 40; contra Nims 1950: 27). Though many people in villages in Egypt know how to build using mud-brick, given time and monetary resources, they may hire masons to undertake the construction; these tend to be local men for whom the job of mason is a secondary or tertiary occupation (behind farming and/or fishing), a self-taught occupation based on personal experience (Henein 1988: 39 - 40). While the laying of walls and the construction of flat roofs is generally non-specialized, the erection of domes and vaults is a specialized endeavor. This knowledge survives in the southern-most reaches of Egypt and into the Sudan, where Nubians employed techniques similar to those used by the ancient Egyptians to create vaults, which did not require expensive wooden framing to hold bricks in place while the vault was under construction (Fathy 1989: 8 - 12). The vaults created thusly are termed inclined vaults, as they are laid by leaning the parabola of the vault against an end wall for support, and are attested in ancient Egypt from the 1st Dynasty into the Coptic Period (Spencer

1979: 6 - 18, 123, pls. 7 - 18).

Art and Artifacts

The modern accounts of mud-brick production seem to accord well with what is known of ancient production. Sporadic artistic, artifactual, and textual evidence bear witness to the nature of the ancient methods of production and work organization, and the massive volume of surviving brick itself stands as an under-utilized potential resource for understanding ancient production and construction techniques.

One of the most famous artistic sources for information concerning the ancient Egyptian production of mud-brick is a scene in the tomb of Rekhmira (TT 100), vizier under Amenhotep II and Thutmose III (Davies 1935: XVI, XVII, 1943: 54 - 55, pls. LVIII - LIX). In this scene, which occurs on the lower portion of the eastern half of the south wall of the passage, a reconstructed, large standing figure of vizier Rekhmira oversees construction work undertaken by Egyptian, Nubian, and Syrian servants and slaves depicted in four registers before him. Included in a series of scenes depicting the production and erection of statues, as well as other constructions, the brick-making scene pictures the stages of activity known from modern methods of brick fabrication: men mixing mud next to a pool from which workers supply the necessary water for the earth-straw mixture; men carrying the prepared earth-straw mixture in round baskets to the brick field; men striking bricks in standard-fashion molds; and men transporting completed bricks to a construction ramp. The inscription carved in the triangular space above the ramp reads:

> *Drive home the blocks; bring earth* (*mud mortar*) *and the very large number of mats* (*needed*)*; build as a man adroit of finger and alert in his tasks. Let the supervisors be men of vigor who listen to the counsels of this magnate, one experienced in working gangs and who can lay down procedure for superintendents, and who supplies his…for us with food and drink, all of it being good. He is our director, inspired by the desire that the king may endure* [*to eternity*] *and that he, the King of Upper and Lower Egypt, Menkheperre, may build a sanctuary to* (*the gods*) *in order that they may give him its equivalent return in millions of years* (Davies 1943: 55).

Beyond the assurances (in this funerary setting, directed at the gods rather than at the work crew depicted) that Rekhmira is a capable man for the job, the inscriptions accompanying the scene are informative in that they articulate that the construction logically required a certain level of organization, not only of the workers themselves, but also of the overseers who administered in lower positions. Based on the depiction of production and construction, it is possible to infer that the two processes were considered as separate enterprises, since the brick production was watched over by one overseer perched on a brick facing left in the upper subregister, while the construction was directed by a second overseer, facing right toward the ramp being built. Both overseers were probably then directed by a superior, perhaps Rekhmira himself, though most likely by another intermediate level manager in the long chain of bureaucracy between the vizier and the workers. It might also be suggested based on the scene that the making of the unfired bricks for large state projects, such as building at Karnak, was undertaken somewhere close to the construction site, a practicality that reduced the labor needed to carry the bricks from the production area to the construction area; however, given the massive construction projects undertaken at Karnak during the New Kingdom and the idiosyncratic nature of the Egyptian's depiction of perspective, it is always possible that the temple had an area of centralized mud-brick production and that the bricks were then used throughout the temple complex (and perhaps in neighboring complexes as well).

In addition to the single scene from the tomb of Rekhmira, the molding of unfired mud-bricks can also be an element in the idealized and sanitary depictions of royal foundation ceremonies. Depictions of striking

bricks during foundation ceremonies are most common in the Late Period, and one such scene is represented at Edfu in the second hypostyle hall on the left-hand side of the east wall in the bottom register, where the king precedes from the palace accompanied by royal standards, breaks ground with a *mr*-shaped hoe before a hieracocephalic Horus, and then makes a super-sized brick in an over-sized brick mold (Chassinat and Rochemonteix 1894 - 1934, Vol. 10: pl. XLe). Representations of brick making during foundation ceremonies are rarely attested also for the New Kingdom, for example, during the reign of Hatshepsut, where the queen/king, accompanied by her *ka*, kneels in order to form a brick in a mold; the scene is labeled "making bricks" (*sḫt ḏb.wt*; Fathy 1989: pl. 1).

Brick molds, both regular-sized and miniature, are attested as items in foundation deposits from the Middle Kingdom into the Ptolemaic Period (Weinstein 1973: 419 - 420), for instance, from the foundation deposits of Hatshepsut at Deir el-Bahri (Weinstein 1973: 98 - 99), of Ramesses II at the Ramesseum (Weinstein 1973: 232, 260), and of a king *Mn-ḫpr-Rᶜ Mny(-Rᶜ)*, tentatively dated to the time of the 25th Dynasty, at a small temple in northern Nubia on the island of Sai (Weinstein 1973: 260). Apart from molds from foundation deposits, which were probably mainly ceremonial and symbolic (especially in the case of miniature molds), brick molds have also been found in other archaeological contexts, such as a mold from the 12th Dynasty found in the course of excavations at el-Lahun, the mud-brick pyramid of Senusret II (Petrie 1917: 42, pl. 77). Ancient molds are of the same form as modern molds employed in Egypt but have mortised, rather than nailed, corners (Petrie 1917: 42). No molds have yet been found that would have been used to make bricks of special shapes, such as curved cornice or column bricks (Spencer 1979: 3).

Magic Bricks

For the ancient Egyptians, bricks not only were construction material—the building blocks of physical structures—but also were objects that could be imbued with symbolic significance. During the New Kingdom, four magic mud-bricks, one for each cardinal direction, came to be included in tombs as an element of funerary equipment and were recovered from the royal tombs of Thutmose IV, Amenhotep III, Tutankhamen, Ay, Horemheb, Ramesses I, Sety I, and Ramesses II, as well as from the tombs of queens Sitra, Nefertari, and Bentanti; they could also be included in private tombs (Silverman 1996: 725 - 733; Thomas 1964: 72). These magic bricks were inscribed in hieratic with Spell 151 from the *Book of the Dead* and were usually installed in niches carved in the walls of the burial chamber (Roth and Roehrig 2002: 126 - 129; Scalf 2009; Silverman 1996: 725 - 741; Thomas 1964: 71 - 72). Each brick was provided with a hole in it to fit an amulet, usually a *ḏd*-amulet of blue faience and gold on the western brick, a recumbent Anubis of unbaked clay on the eastern brick, a small wooden shabti-like statuette on the northern brick, and a reed with a wick in it, probably a torch or flame of some kind, on the southern brick (Heerma van Voss 1986: 1402; Scalf 2009; Thomas 1964: 71). The bricks and amulets were provided as an apotropaic feature of the funerary equipment, acting as the protectors of the Osiris residing in the tomb.

As well as occurring in funerary contexts, bricks with magically protective qualities were also employed during birthings. Long known from textual and representational sources, a single example of a decorated birth brick was discovered during the course of excavations at South Abydos in the Middle Kingdom town adjacent to (and probably attached to/dependent on) the memorial complex of Senusret III (Wegner 2002: 3 - 4). The brick is decorated with a polychrome scene on the base depicting a mother holding her baby and attended by two females; the entire scene is flanked by Hathor-headed divine standards. Anthropomorphic and zoomorphic figures, which are usually shown protecting the sun god Ra during his daily rebirth on the eastern

horizon, decorate the preserved sides of the brick, creating explicitly magical scenes of a type known from Middle Kingdom "magical knives," but also linking to beliefs concerning funerary practices and the afterlife (Roth and Roehrig 2002: 136 - 137; Wegner 2002: 3 - 4).

Stamped Bricks

Mud-bricks produced for royal construction projects were sometimes stamped with the name of the reigning king—or a queen, a prince, or a high official—or the name of the building.

As in the practice of administrative sealing, a distinction perhaps should be drawn between the stamp used to impress the mark on the brick and the impression itself. These are generally referred to as seal and sealing in the administrative realm and for bricks probably should be termed stamp and stamping. There exist examples of bricks inscribed with ink (Harvey 1998: 190) or using a finger, which perhaps lie in the conceptual genealogy of the stamped mud-bricks, as probably were quarry marks and mason's marks on stone blocks, but are usually not considered as a part of the corpus of stamped mud-bricks (Spencer 1979: 146).

The earliest known examples of stamped bricks occurred during the reign of the first king of the 18th Dynasty, Ahmose. The practice of stamping unfired bricks has been attested fairly regularly throughout the 18th and 19th Dynasties, and was continued sporadically into the 26th Dynasty (Spencer 1979: 144 - 146). Stamped mud-bricks can be an important chronological resource to pinpoint the date of constructions, which otherwise could only be broadly dated to a dynasty or kingdom; with this more accurate information, it sometimes becomes possible to track construction phases, not only between reigns but also within reigns as stamp types changed (Emery 2006; Harvey 1998: 190 - 206, figs. 34 - 36; Hayes 1951: 162 - 164, figs. 24, 30). On the stampings, the names of kings are encircled by a simple oval or by a true cartouche, while the names of the high priests of Amen found on stampings from the 21st Dynasty and the names of buildings or complexes more commonly are enclosed in rectangles (Spencer 1979: 144). In the case of bricks stamped with personal names, it is generally assumed that the name impressed in the bricks is the name of the person responsible for the construction of the building, and, at memorial complexes, usually also of the person to whom the building was dedicated (Harvey 1998: 193, 202 - 203, 207).

Occasionally, the stamps themselves are encountered in archaeological excavations, including, from the 18th Dynasty, a limestone stamp with the name of Thutmose I (Weinstein 1973: 89 - 90), half of a clay stamp found below the pavement level of the temple of Amenhotep II at Buhen and inscribed with his name ([*ỉ*]*mn-ḥtp ḥḳꜣ-Wꜥst*; Randall-MacIver and Woolley 1911: 90, pl. 43), and, from the 25th Dynasty, a copper stamp with a handle from the reign of Shabaqo (*Šꜣ-bꜣ-kꜣ mr ỉmn*) and a stone stamp bearing the prenomen of Shabitqo (*Ḏd-kꜣ-Rꜥ*; Spencer 1979: 45, pl. 36 #94 - 95, respectively). Much more common are the stamped bricks themselves, with the majority of 18th Dynasty examples reportedly coming from the Theban area, particularly the west bank royal memorial complexes (Spencer 1979: 144), though they are attested during this period elsewhere in the country, for example, in the constructions of Ahmose at Abydos (Harvey 1998: 186 - 209); stamped bricks from later periods also occur outside Thebes (Spencer 1979: 108).

Bibliographic Notes

Spencer (1979) remains the standard reference for mud-brick architecture in ancient Egypt, though Kemp (2000) is the most recent and most comprehensive treatment of earth architecture,

including mud-brick. Arnold (2003) offers short, useful descriptions of various mud-brick architectural styles and construction techniques. Clark and Engelbach (1930) and Lucas (1962) offer investigations into Egyptian construction techniques, covering both the production of and construction with mud-brick. Modern ethnographic accounts of mud-brick production and use can be found in Fathy (1989) and Henein (1988).

References

Arnold, Dieter
2003 *The encyclopedia of ancient Egyptian architecture* Princeton: Princeton University Press.

Chassinat, Émile, and Maxence de Rochemonteix
1894- *Le temple d'Edfou*. 14 volumes ("Edfou I - XIV": 1894 - 1934). Mémoires publiés par les membres de la mission archéologique française au Caire. Cairo: Institut français d'archéologie orientale.

Clarke, Somers, and Richard Engelbach
1930 *Ancient Egyptian masonry: The building craft*. London: Oxford University Press, Humphrey Milford.

Davies, Norman de Garis
1935 *Paintings from the tomb of Rekh-mi-Rē at Thebes*. Publications of the Metropolitan Museum of Art, Egyptian Expedition 10. New York: Metropolitan Museum of Art, The Plantin Press.
1943 *The tomb of Rekh-mi-Rē at Thebes*. Publications of the Metropolitan Museum of Art, Egyptian Expedition 11. New York: The Plantin Press, 1944.

Emery, Virginia
2006 *Unwitting monuments of eternity: Mud-brick production and construction.* Annual Conference of the American Research Center in Egypt.

Fathy, Hassan
1989 *Architecture for the poor: An experiment in rural Egypt*. Cairo: American University in Cairo Press. (Originally published 1969 as *Gourna* by the Ministry of Culture, Cairo.)

French, Charles
1984 A sediment analysis of mud brick and natural features at el-Amarna. In *Amarna reports I*, ed. Barry Kemp, pp. 189 - 201. London: Egypt Exploration Society.

Harvey, Stephen
1998 The cults of king Ahmose at Abydos. PhD dissertation, University of Pennsylvania.

Hayes, William
1951 Inscriptions from the palace of Amenhotep III. *Journal of Near Eastern Studies* 10(3), pp. 156 - 183.

Heerma van Voss, Matthieu
1986 Ziegel (magische). In *Lexikon der Ägyptologie*, Vol. 6 (column 1402), ed. Wolfgang Helck, and Eberhard Otto. Wiesbaden: Otto Harrassowitz.

Henein, Nessim Henry
1988 *Mari Girgis: Village de Haute-Égypte*. Bibliothèque d'étude 94. Cairo: Institut français d'archéologie orientale.

Hohn, Charles
2003 *ABCs of making adobe bricks*. Las Cruces, N.M.: Cooperative Extension Service, New Mexico State University, College of Agriculture and Home Economics. (Originally published in 1989.)

Janssen, Jac
1975 *Commodity prices from the Ramessid Period: An economic study of the village of necropolis workmen at Thebes*. Leiden: Brill.

Jéquier, Gustave
1924 *Manuel d'archéologie Égyptienne: Les élément de l'architecture*. Paris: Auguste Picard.

Kemp, Barry
2000 Soil (including mud-brick architecture). In *Ancient Egyptian materials and technology*, ed. Paul T. Nicholson, and Ian Shaw, pp. 78 - 103. Cambridge: Cambridge University Press.

Lucas, Alfred
1962 *Ancient Egyptian materials and industries*. 4th edition, revised and enlarged by John Richard Harris. London: Edward Arnold. (Originally published 1926.)

McHenry, Paul
1989 *Adobe and rammed earth buildings: Design and construction*. Tucson: The University of Arizona Press. (Reprint. Originally published 1984 by Wiley, New York.)

Mond, Sir Robert, and Oliver Humphrys Myers
1934 *The Bucheum, Vol. I: The history and archaeology of the site*. Memoir of the Egypt Exploration Society 41. London: Egypt Exploration Society.

Morgenstein, Maury, and Carol Redmount
1998 Mudbrick typology, sources, and sedimentological composition: A case study from Tell el-Muqdam, Egyptian Delta. *Journal of the American Research Center in Egypt* 35, pp. 129 - 146.

Nims, Charles
1950 Bricks without straw? *The Biblical Archaeologist* 13(2), pp. 21 - 28.

Oates, David
1990 Innovations in mud-brick: Decorative and structural techniques in ancient Mesopotamia. *World Archaeology* 21(2), pp. 388 - 406.

Petrie, William Matthew Flinders
1917 *Tools and weapons*. London: British School of Archaeology in Egypt.

Randall-MacIver, David, and Leonard Woolley
1911 *Buhen*. Philadelphia: The University Museum.

Roth, Ann Macy, and Catherine Roehrig
2002 Magical bricks and the bricks of birth. *Journal of Egyptian Archaeology* 88, pp. 121 - 139.

Scalf, Foy
2009 Magical bricks in the Oriental Institute Museum of the University of Chicago. *Studien zur Altägyptischen Kultur* 38, pp. 275 - 295.

Silverman, David
1996 Magical bricks of Hununro. In *Studies in honor of William Kelly Simpson*, Vol. 2, ed. Peter der Manuelian, pp. 725 - 741. Boston: Museum of Fine Arts.

Spencer, A. Jeffrey
1979 *Brick architecture in ancient Egypt*. Warminster: Aris & Phillips.

Thomas, Elizabeth
1964 The four niches and amuletic figures in Theban royal tombs. *Journal of the American Research Center in Egypt* 3, pp. 71 - 78.

van Beek, Gus, and Ora van Beek
2008 *Glorious mud! Ancient and contemporary earthen design and construction in North Africa, Western Europe, the Near East, and Southwest Asia*. Washington: Smithsonian Institution Scholarly Press; Lanham, Md.: Published in cooperation with Rowman & Littlefield Publishers.

Vitruvius Pollio, Marcus
1960 *De architectura*. Translated by Morris Hicky Morgan. New York: Dover Publications. (Originally published in 1914 by the Harvard University Press.)

Wegner, Josef
2002 A decorated birth-brick from South Abydos. *Journal of Egyptian Archaeology* 21, pp. 3 - 4.

Weinstein, James
1973 Foundation deposits in ancient Egypt. PhD dissertation, University of Pennsylvania.

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Figure 1. Unmolding new mud-brick. Photograph by Willeke Wendrich.

Figure 2. Striking new mud-brick. Note the earth-straw mixture in the background and brick turned for drying in the foreground. Photograph by Willeke Wendrich.