



Amarna gypsite: A new source of gypsum for ancient Egypt



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ABSTRACT

Gypsum was widely employed in Egypt for plaster and mortar from late Predynastic times onward with the most extensive and varied use of this mineral occurring at Amarna (ancient *Akhetaten*) during the New Kingdom's Eighteenth Dynasty. It is traditionally thought the gypsum was obtained from the Faiyum Depression, but a new and larger source has been discovered on top of the limestone plateau to the north and east of Amarna. Here there are nearly three square kilometres of quarries dating mainly from the Old to New Kingdoms. The gypsum occurs in a thin soil on the limestone, forming a calcite-rich deposit known as gypsite. The total calcium sulfate content of gypsite samples (gypsum + bassanite + anhydrite) ranges from 24 to 74% with calcite comprising nearly all the remainder.

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1. Introduction

When gypsum is heated (calcined) between 100 and 170 °C, it loses three-fourths of its water to become a material variously known as burnt gypsum, plaster-of-Paris, and the mineral bassanite. When mixed with water, bassanite recrystallizes back to gypsum and in the process forms a moderately hard material that can be used as a plaster or mortar. Gypsum was employed in Egypt for both purposes from late Predynastic times onward (Arnold, 1991: 292–293; Lee and Quirke, 2000: 117–118; Lucas, 1962: 6–7 and 76–79; Petrie, 1910: 142–146) (see Table 1 for the ancient Egyptian chronology). Its use was especially heavy during the late Eighteenth Dynasty reign of King Akhenaten (1353–1336 BCE, the Amarna Period) at Tell el-Amarna (or simply Amarna), the fanciful modern name for the ancient city of *Akhetaten* (Fig. 1). Here its principal application was for the foundations of stone buildings (as ‘gypsum concrete,’ a mixture of gypsum and stone chippings), but it was also used for pavements, wall veneer, interior coatings of offering basins, repair of limestone sculptures and architectural elements, and as an adhesive for mortise-and-tenon joins in multi-piece statuary and for stone and glass inlays (Kemp, 2012: 64–69; Kemp et al., 2012, 2013, 2014; Winkels, 2013, 2014; Barry Kemp and Alexandra Winkels, pers. comm.). Clay (or mud) plaster and mortar, derived either from Nile alluvium or clay-rich calcareous soil (*‘hiba’*), were also employed at Amarna and elsewhere with clay plaster sometimes used as a substrate for gypsum plaster (Arnold, 1991: 291–293; Kemp, 2000: 92; Lucas, 1962: 75–76 and 353–354). Small cone-shaped

masses of gypsum have been recovered from excavations at Amarna and these apparently represent batch samples for builders (Pendlebury, 1951: 180–181). Some cones have production dates written in hieratic script with black ink and identify themselves as “*ḳḳ* [or *qedj*; gypsum] of *Akhetaten*” (Harris, 1961: 90; Pendlebury, 1951: 180; Spiegelberg, 1923). The use of gypsum plaster was so prevalent at *Akhetaten* that two of the city’s boundary stela (S and U) warn the reader that the inscription must not be covered over with *ḳḳ* (Davies, 1908: pls. 25–26). The word *ḳḳ* is a Semitic loanword introduced in the Eighteenth Dynasty and is probably derived from the Akkadian *gaššu*, which is the source of the Greek γυψος or *gypsos* and thence the English gypsum (Harris, 1961: 91; Hoch, 1994: 307–308; Oppenheim, 1956: 54–55). The derivative word *ḳḳy* [gypsum worker] was also in use at *Akhetaten* for the people who either calcined the gypsum or applied the plaster and mortar (Frankfort and Pendlebury, 1933: pl. 57). While the words *ḳḳ* and *ḳḳy* might suggest that either the calcining technology or specialized gypsum workers came from outside of Egypt—possibly Mesopotamia—in the early New Kingdom, this cannot be the case since gypsum plaster and mortar had already been employed in Egypt for millennia. Conceivably, however, some innovation in gypsum technology or application may have been introduced from the East along with the word *ḳḳ*.

Prior to the author’s fieldwork at Amarna in 2014 and 2015, it was assumed that the gypsum used there was brought from sources elsewhere in Egypt. Significant occurrences of gypsum in Egypt are of four types: (1) Pleistocene and Holocene evaporite lake deposits between Port Said and Suez, in the Western Desert oases, and in the Mariout region from Alexandria southwest to el-Hammam; (2) thick veins cutting Eocene mudstone in the Faiyum Depression; (3) bedded Miocene

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Table 1
Ancient Egyptian chronology*.

Predynastic Period (before 2950 BCE)
Dynastic (Pharaonic) Period
Early Dynastic Period: Dynasties 1–3 (2950–2575 BCE)
Old Kingdom: Dynasties 4–8 (2575–2125 BCE)
First Intermediate Period: Dynasties 9–11 (2125–1975 BCE)
Middle Kingdom: Dynasties 11–14 (1975–1640 BCE)
Second Intermediate Period: Dynasties 15–17 (1640–1540 BCE)
New Kingdom: Dynasties 18–20 (1540–1075 BCE)
Third Intermediate Period: Dynasties 21–25 (1075–715 BCE)
Late Period: Dynasties 25–30 (715–332 BCE)
Graeco-Roman Period
Ptolemaic (Macedonian) Period (332–30 BCE)
Roman Period (30 BCE – 395 CE)

* adapted from Baines and Malek (2000: 36–37).

formations along the Red Sea coasts of both the Sinai and mainland Egypt (EGSMA, 1979; Hume, 1912: 42–43; Hussein, 1990: 559; Lucas, 1962: 78); and (4) efflorescent deposits in thin soils developed on top of the Eocene limestone of the Nile Valley in the Girza and Helwan areas (Aref, 2003; Hume, 1905: 6–7, 1910: 11, 1912: 42; Ismail and Farag, 1957: 131; Lucas, 1924: 129, 1962: 78), and near Wadi el-Sheikh (Blanckenhorn, 1901: 488; Harrell, 2014: 26) (Fig. 1). Gypsum also occurs widely across Egypt as thin veins in a variety of sedimentary

rocks and soils. There are three ancient gypsum quarries known among these deposits: two in the Faiyum at Umm el-Sawan and near Qasr el-Sagha that date to the Early Dynastic period and Old Kingdom (Caton-Thompson and Gardner, 1934; Harrell, 2002: 233–235; Haldal et al., 2009), and the third on the southern Red Sea coast near Wadi el-Anbaut and dating to the early Roman period (Harrell, 2010). Egyptologists have traditionally favored the Faiyum as the principal source of gypsum for ancient Egypt (e.g., Lucas, 1962: 78–79; Bard, 2008: 62) but this is not supported by the archaeological and petrological evidence. A more likely source, certainly for Amarna but also for the rest of Egypt, is the soil that forms on limestone.

The impure form of gypsum found in some soils is referred to as gypsite (also gypcrete and gypsum earth) and occurs in arid regions around the world wherever the underlying bedrock contains gypsum (Adams, 1904: 53–67; Dregne, 1976: 42 and 173–175). The mineralogical composition of gypsite can be highly variable with the only constant the presence of significant amounts of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, calcium sulfate dihydrate) or other forms of calcium sulfate, including bassanite ($\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$, calcium sulfate hemihydrate) and anhydrite (CaSO_4 , anhydrous calcium sulfate). Common impurities include calcite, clay minerals, halite, and quartz.

The gypsite deposit near Helwan, developed on top of gypsiferous limestone, is especially rich and was a major source of gypsum for Egypt's plaster industry in the early 1900's (Hume, 1905: 6–7, 1910:



Fig. 1. Map of Egypt showing localities mentioned in the text.

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