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Sacred soils of ancient Egypt

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ABSTRACT

Mid-Holocene paleosols within archeological excavations at temples of Ancient Egypt and Sudan are here documented from the field and from publications in order to examine the relationship between particular cults and soils. The principal finding is that the same kind of paleosols were seen at the different temples of the same deity, but different kinds of paleosols at temples of different deities. Temples of Isis and Osiris, for example, are on Mollisols, in contrast with temples of Horus and Hathor on Alfisols. Different soils supported different livelihoods, castes and cults, and fostered tribal theologies as distinct as those of pastoral Masai versus agrarian Kikuyu. Ancient Egyptians were aware of these differences, as revealed by inscriptions at the temple of Horus at Edfu. These texts outline a soil classification used by the predynastic ruler Tanen for temple establishment on each soil type as it emerged from the primeval flood. Soils have long been a basis for human livelihoods and religion.

1. Introduction

The central hypothesis of this study is that the economic and cultural basis of different ancient religious cults may be revealed by soils at their temples, as demonstrated for temples in Ancient Greece (Retallack, 2008), Italy (Retallack, 2019a), India (Kramrisch and Burnier, 1976), Palestine and China (Winiwarter and Blum, 2006). Herodotus (II-50; Holland, 2013) traced the origin of classical Greek religion to Egypt. Soil resources shaped religious views in many parts of Africa. The Masai are a Kenyan pastoral tribe, who live from blood and meat of their cattle. For the Masai, the idea of tilling their Rift Valley soils (Aridisols and Mollisols) is sacrilege, because that is the abode of ancestors. Their god is in the sky above their open rangelands (Bentsen, 1989). In contrast, nearby Kikuyu of the humid rift margins are an agrarian tribe cultivating volcanic soils (Andisols) and deep tropical soils (Oxisols). Their god lives on remote Mt Kenya, and is the supreme deity of ancestral spirits that return to sacred trees (Routledge and Routledge, 1910; Kenyatta, 1978). Similar pastoral and agrarian cults in Egypt during predynastic times are revealed by cattle-human sculptures and vegetation designs (Wilkinson, 2003). Varied tribes and cults blended into polytheistic city states when Menes (2920 BCE) united the Nile Valley into a civilization that lasted for three millenia. Monotheistic cults imposed by ruling elites, notably by Akhnaten (1353–1335 BCE), were short lived (Hornung, 1999), and are not addressed here. Also beyond the scope of this study are the cults of particular pharaohs, their mortuary temples and pyramids (Aubry et al., 2009; Butzer et al., 2013). This study describes paleosols at Egyptian temples in the field and in published literature as additional clues to the economic basis of ancient cults and their calendars, but is limited to the main Ancient Egyptian deities and mid-Holocene paleosols of the founding period of Egyptian religion.

One difficulty with ancient Egyptian religion is its diversity: one compilation details 476 deities, and estimates that there were almost 1500 deities (Wilkinson, 2003). This complexity was reduced by Herodotus (II-4, II-50; Holland, 2013), who considered Egyptians the first people with twelve main gods, corresponding to months of the year, and the source of Greek polytheism. Herodotus (I-59: Holland, 2013) also ranked the greatest religious festivals: first for Bastet at Bubastis, second for Isis at Busiris, third for Neith at Sais, fourth for Amun at Heliopolis, fifth for Leto at Buto, and sixth for Ares at Papremis. Especially prominent were five deities whose day-festivals were national holidays at the end of twelve 30-day months bringing the year to 365 days: Osiris, Isis, Horus, Seth, and Thoth (Wilkinson, 2003). Another indication of importance is the number and magnificence of dedicated temples, which also reflect political influence of New Kingdom Amenophis III (1391–1353 BCE) and Ramesses II (1290-1224 BCE: Wilkinson, 2000). Over this great sweep of history Egyptian cults changed, for example, evolution of Hathor from a cow goddess toward a goddess of love conflated with Aphrodite in Graeco-Roman Egypt (332 BCE to 395 CE: Lesko, 1999). Graeco-Roman Egypt was a time of widespread syncretism of cults, such as Serapis combining Osiris and Apis, and a combined Isis-Aphrodite (Wilkinson, 2003).

Another difficulty in determining the role of soil in Egyptian cults is that the religion dates back to mid-Holocene, about 5000 years ago, when people were driven out of the Sahara by global cooling and drying (Hassan, 1980). Surface soils reflecting conditions of the past 2500 years, are less important as a background to Egyptian religion than

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Fig. 1. Temples of Ancient Egypt with soils examined here (solid symbol) and unexamined (open symbol). Distribution of alluvial soils is from F.A.O. (1977).

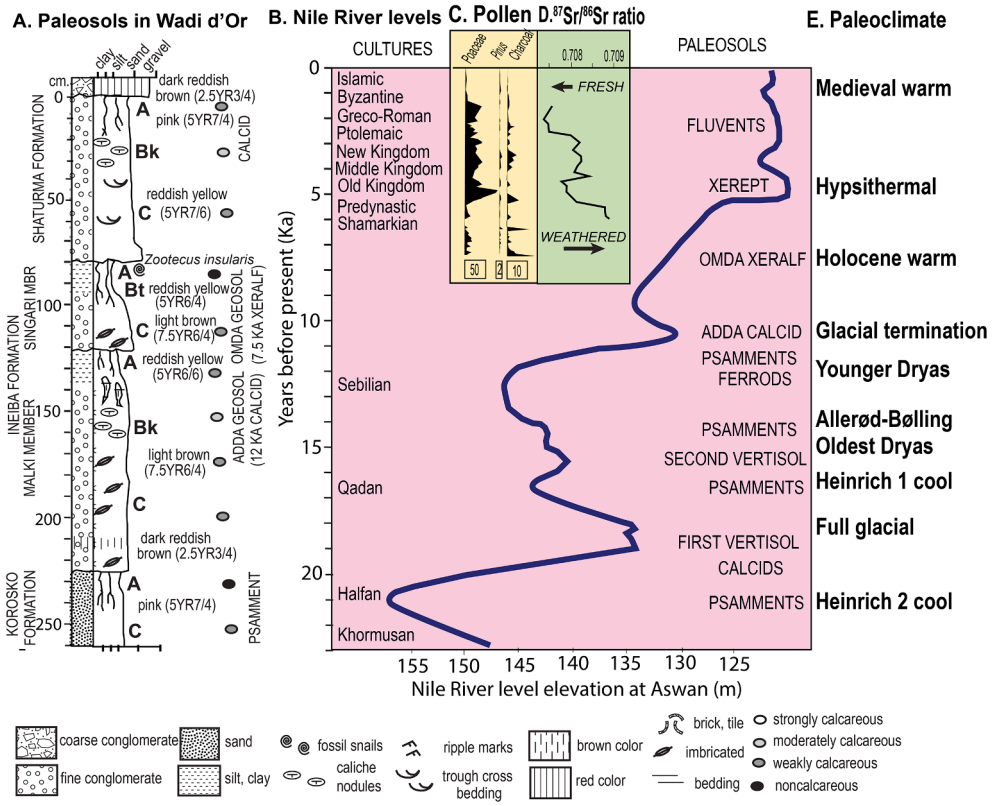

Fig. 2. Records of climate change in Egypt from (A) paleosols in Wadi Or (from Butzer, 1966); (B) pollen in deltaic core S53 of Bunillus Lagoon, Nile Delta (from Bernhardt et al., 2012); (C) strontium isotopic composition of Nile alluvium in deltaic core S21 (Stanley et al. 2003) and (D) Nile River levels (de Heinzelin, 1968).

middle to early Holocene paleosols. Paleosols are ancient soils, formed by a concatenation of past climate, vegetation, and other factors that can be inferred from particular profile features (Retallack, 2019b). These connections will be discussed here from observations of paleosols in archeological excavations (Butzer, 1966; Vermeersch, 2002; Butzer et al., 2013; Toonen et al., 2018).

2. Background to soils and vegetation of ancient Egypt

Herodotus (II-12: Holland, 2013) ably describes the soil of Egypt, as "*black, and crumbles easily, which suggests that it must originally have been alluvial mud brought down by the river out of Ethiopia. We know that Libyan soil, by contrast is a reddish deposit overlying sand, while that of Arabia and Syria is claylike, and rests on a stony base*". Nile alluvial soils (Fig. 1) have been similar down the ages. Desert soils (Calcids and Psamments of sand dunes) encroached on them during drying of the last glacial maximum (Fig. 2B), and Nile alluvium has been enriched with desert loess evident from surrounding regions (Yaalon, 1987). Before that time grassland soils (Mollisols and Vertisols) and woodland soils (Xeralfs) like those of Sudan (F.A.O,1977) formed in Egypt, and were buried as paleosols (Fig. 2A). Near Edfu in Upper Egypt, charcoal of *Acacia*, a grassland shrub, has been dated to 3400–2900 BCE (Newton and Midant-Reynes, 2007). In the Nile Delta, early to mid-Holocene warmth and humidity is marked by increased abundance of grass and tree pollen (Fig. 2C: Kholeif and Mudie, 2009; Bernhardt et al., 2012). Strontium isotopic composition of Nile alluvium from deltaic core S21 (Fig. 1) shows a mid-Holocene peak (Fig. 2D) indicative of increased chemical weathering (Stanley et al., 2003). Nile River levels inferred from nilometer records and terrace incision (Fig, 2D), show a mid-Holocene low stage with deforestation and deglaciation of Ethiopian highlands, as well as dramatic full glacial high stands (de Heinzelin, 1968). These changes also have been attributed to weaker summer monsoons in the Ethiopian source of the Nile, with southward shift of the summer Intertropical Convergence Zone (Welc and Marks, 2014).

3. Materials and methods

3.1. Fieldwork

This research characterized mid-Holocene paleosols at as many temples in Egypt with known deity as possible. A total of 62 Egyptian temples are dedicated to known dieties, not including mortuary temples or pyramids (Wilkinson, 2000), and this study obtained profiles and other data from 32 of them (Fig. 1; Table 1). These profiles are from the only suitable local exposures, such as road cuts, trench excavations, and auger cores, as close to the temples as possible. They are mostly in flat areas with little lateral soil variation, and further studies of local soil variation would be logistically impossible for all sites (Table 1). Paleosol excavations were photographed (Fig. 3) and measured with a milliners tape to prepare a graphic column, with color from a Munsell color chart, and calcareousness from application of dilute (10 %) hydrochloric acid (Fig. 4).

3.2. Literature data

Archeological literature supplied additional descriptions of living floors and soil surfaces from artefact concentrations, along with descriptions of color, texture, and structures of soil profiles as a basis for preparation of graphic soil columns (Fig. 4; Table 1: Adams, 1864; Petrie and Mackay, 1915; Anwar, 1959; Waechter, 1965; Anthes, 1965; Wendorf, 1968; Issawi, 1976a, 1976b, 1976c; Wells, 1985; Redmount and Friedman, 1997; Morgenstein and Redmount, 1998; Cagle, 2001; Paolini, 2005; Wilson et al., 2005; Davoli and Kaper, 2006; O'Connor, 2009; Karakhanyan et al., 2010; Ghilardi and Boraik, 2011; Porter and Corda 2013; Marouard, 2016; Toonen et al., 2018; Ullmann et al., 2019). Especially useful was paleosol identification and correlation in Egypt

Table 1
Paleosols observed at the ancient temples of Egypt.

Deity	Temple	Age BCE	Soil observed	Northing	Easting	
Amun	Karnak	1290	anthropic	25.7195	32.65612	Retallack notes 19 January 2019; deep core **of** Ghilardi and Boraik 2011
Amun	Luxor	1391	anthropic	25.7007	32.63903	Retallack notes 18 January **2019**
Amun	Abu Simbel	1290	anthropic	22.33565	31.62722	Retallack notes 16 January 2019; Adams 1864**p. 13**
Amun	Tanis (San el Hagar)	1040		30.97665	31.88331	site 8898 of Wendorf, 1968
Amun	Dabod	300	anthropic	23.86994	32.86923	Adams 1864p. 14
Amun	Amada	1450	anthropic	22.72371	32.23701	Adams 1864p. 13
Amun	Hibis (Hebet)	712	anthropic	25.47644	30.55698	profile 40 of Anwar, 1959
Bastet	Bubastis (Tell Basta)	883	Ochrept	30.57039	31.51492	Core B2 of Ullmann et al., 2019
Bastet	Leontopolis (Tell el Muqdam)	1070	Ochrept	30.68363	31.35449	Pit QSTTB of Redmount and Friedman 1997, Morgenstein and Redmount 1998
Hathor	Dendera	2575	Xeralf	26.14207	32.6704	Fig. 14 of Marouard 2016, fig. 51 of Issawi 1976c
Hathor	Kom el Hisn	1290	Xeralf	30.79613	30.60003	DU-7 (SU-18,19,20) of unit 1192/1035p.98 unstratified silty **sand of** Cagle, 2001
Hathor	Deir el Medina	1306	Xeralf	25.72876	32.60203	Trench 2 of Karakhanyan et al. 2010
Horus	Kom Ombo	1550	Ochrept	24.45181	32.92806	Retallack notes 18 January **2019**
Horus	Hierakonpolis (Kom El Ahmar)	3920	Ochrept	30.46338	30.98471	photo p.17 of Wilkinson, 2017; profile E71P1 of Issawi 1976a
Isis	Philae	690	Xeroll	24.02686	32.88655	Retallack notes 16 January **2019;** Adams 1864**p.15**
Isis	Deir el Shelwit	−69	Xeroll	25.69776	32.5791	AS50 upper paleosol profile of Toonen et al. 2017; Porter and Corda 2013
Isis	Buhen	1427	Xeroll	21.5391	31.32087	ANW3 locality 3 of Waechter 1964
Knum	Elephantine	2920	Calcid	24.08415	32.88644	Retallack notes 17 January **2019**
Mut	Heliopolis (Tell Hisn)	2465	Psamment	30.79613	30.60003	Plate II Petrie and Mackay 1915
Neith	Sais (Sa el Hagar)	2920	anthropic	30.96572	30.76764	Great Pit of Wilson et al. 2005
Osiris	Abydos	2920	Xeroll	26.18407	31.91819	photo plate IX outside entrance to King Peribsen's enclosure p. 192 of O'Connor, 2009**; photo p.143 of Wilkinson, 2017.**
Ptah	Abu Simbel	1290	Fluvent	22.33565	31.62722	Retallack notes 16 January **2019;** Adams 1864**p.10**
Ptah	Memphis (Mit Rahina)	1290	Fluvent	29.84865	31.25309	photos p.114–5 of Wilkinson, 2017**; photo of** Anthes 1965
Ptah	Gerf Hussein	1290	Fluvent	23.04473	32.91508	Paolini, 2005 fig. 16
Ptah	El Derr	1290	Fluvent	22.73106	32.26258	Adams 1864p. 13
Satis	Elephantine	2920	Calcid	24.08474	32.88665	Retallack notes 17 January 2019**;** Wells 1985
Sekhmet	Memphis **(Mit Rahina)**	1290	Fluvent	29.84865	31.25309	photos p.114–5 **of Wilkinson, 2017; photo of** Anthes 1965
Sekhmet	Kom el Hisn	1290	Fluvent	30.79613	30.60003	DU-7 (SU-17 to 28) **p.104 stratified clay to sand of** Cagle, 2001
Seth	Ombos (Tukh)	1504	Psamment	25.90933	32.69362	Adams 1864p.17
Seth	Avaris (Tell el **Dab'a)**	1319	Psamment	30.78648	31.82032	photo p.109 of Wilkinson **2017**
Thoth	Setwah (Amheida, Trimithis)	610	Xeralf	25.69805	28.86833	photo p. 13 Davoli and Kaper 2006
Thoth	Hermopolis magna (El Ashmunein)	1391	Xeralf	27.78151	30.80406	photo p.139 of Wilkinson 2017

and Sudan by Butzer (1966), Vermeersch (2002), Butzer et al. (2013), and Toonen et al. (2018). Archeological sources also give radiocarbon and cultural dates for the paleosol surfaces in relation to temple foundations.

3.3. *Specific measurements*

The depth to stones greater than 5 cm diameter was measured in cm, following Retallack (2019b), because this can be an important hindrance in cultivation of soils by plowing. The degree of development of the paleosols used an expansion to 100 of the 5-point soil development scale of Retallack (2019b). This is pegged to 40–60 for moderate development with acquisition of a diagnostic argillic or calcic horizon, as defined by the US soil taxonomy (Soil Survey Staff, 2014). In contrast, very weakly developed soils (0–20) have clear sedimentary bedding preserved, and weakly developed soils (20–40) are homogenized by roots and burrows but lack sufficient pedogenic carbonate or clay to qualify as calcic or argillic. The paleosols were identified from profile form and other observations using keys of the US Soil Taxonomy (Soil Survey Staff, 2014) and the WRB (Schad et al., 2015). Equivalent map units in the classification of F.A.O. (1977) are listed in Table 2. All these measurements duplicate those in prior studies of ancient temple soils (Retallack, 2008, 2019a).

4. Results: Paleosols at the temples of ancient Egypt

The best developed paleosols are the prominent pedostratigraphic markers, the Omda and Adda Geosols, seen in river bluffs near Fatirah (Fig. 3A). The Omda profile is 80 cm of red, kaolinitic clay, weakly calcareous toward the base, as in Xeralfs (Soil Survey Staff, 2014) or Calcic Luvisols (of F.A.O,1977 and WRB Schad et al., 2015). The Adda paleosol is 50 cm of smectitic, red, siltstone with calcareous nodular calcification of the underlying Malki Siltstone, as in Calcids (Soil Survey Staff, 2014), Xerosols (F.A.O.,1977), and Calcisols (Schad et al., 2015). These paleosols have been dated at 7.5 Ka and 12 Ka respectively, their clay minerals identified, and mapped from southern Egypt into Sudan by Butzer (1966, 1980, 1997), and Vermeersch (2002). Xerolls (Soil Survey Staff, 2014) or Chernozems (F.A.O.,1977; Schad et al., 2015) were not encountered during my fieldwork, and are rare in Egypt (Labib and Stoops, 1970). Xerolls could be identified in historic photos (Fig. 3E), and described cores (Toonen et al., 2018) from thick dark clayey horizons with crumb ped structure. At Philae (Fig. 4P) the mollic epipedon is above bedded sands, but at Deir el Shelwit (Fig. 4C) the epipedon grades down to an horizon of 2–3 cm diameter rounded calcareous nodules of a Bk horizon. Large micritic nodules 4–5 cm in diameter were found in a silty gray soil above the granite at Elephantine (Fig. 3C, 4 T), but this soil lacked the clay and fine ped structure of Mollisols, and is better identified as a Calcid (Soil Survey Staff, 2014), Xerosol (F.A.O.,1977), and Calcisol (Schad et al., 2015). Weakly developed soils, Xerepts of Soil Survey Staff, 2014) and Cambisols of F.A.O. (1977) and WRB (Schad et al., 2015), lack mollic epipedons or argillic and calcic horizons. Some Xerepts are brown and very rich in cultural debris, principally terracotta shards (Fig. 3B, 4A-C), and can be regarded as anthropic (Soil Survey Staff (2014) or as Technosols of WRB (Schad et al., 2015). Other Xerepts are poor in cultural debris and red in color, because they contain less organic waste (Fig. 3C). Finally, very weakly developed soils, Fluvent (of Soil Survey Staff, 2014) and Fluvisol (of F.A.O. 1977, and WRB of Schad et al., 2015), have thin rooted surfaces (A horizon) over alluvium with

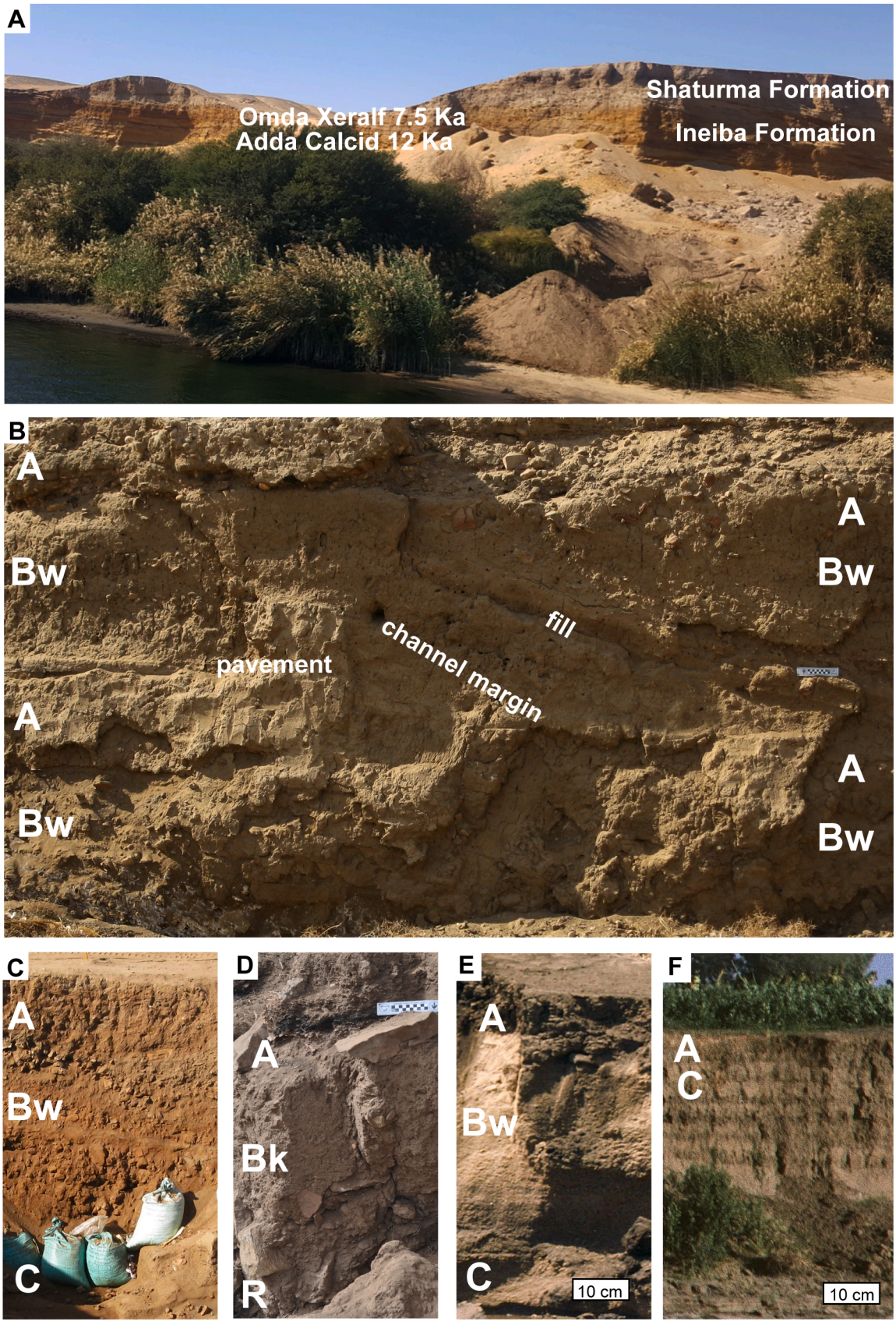

Fig. 3. Examples of paleosols at Egyptian temples: A, named geosols of Butzer (1966) in low terrace of Nile River 1 km southeast of Fatirah; B, two successive anthropic Xerepts, with pavement brick and tile, in cutting immediately east of the first pylon of the temples of Amun at Karnak; C, Xerept in excavation west of museum at temple of Horus at Kom Ombo; D, Calcid with charcoal in upper occupation floor at temple of Knum and Satis on Elephantine Island; E, Xeroll soil exposed during 1974 move of the temple of Isis at Philae; F, Fluvents in bank of the Nile near temple of Ptah at Mit Rahina.

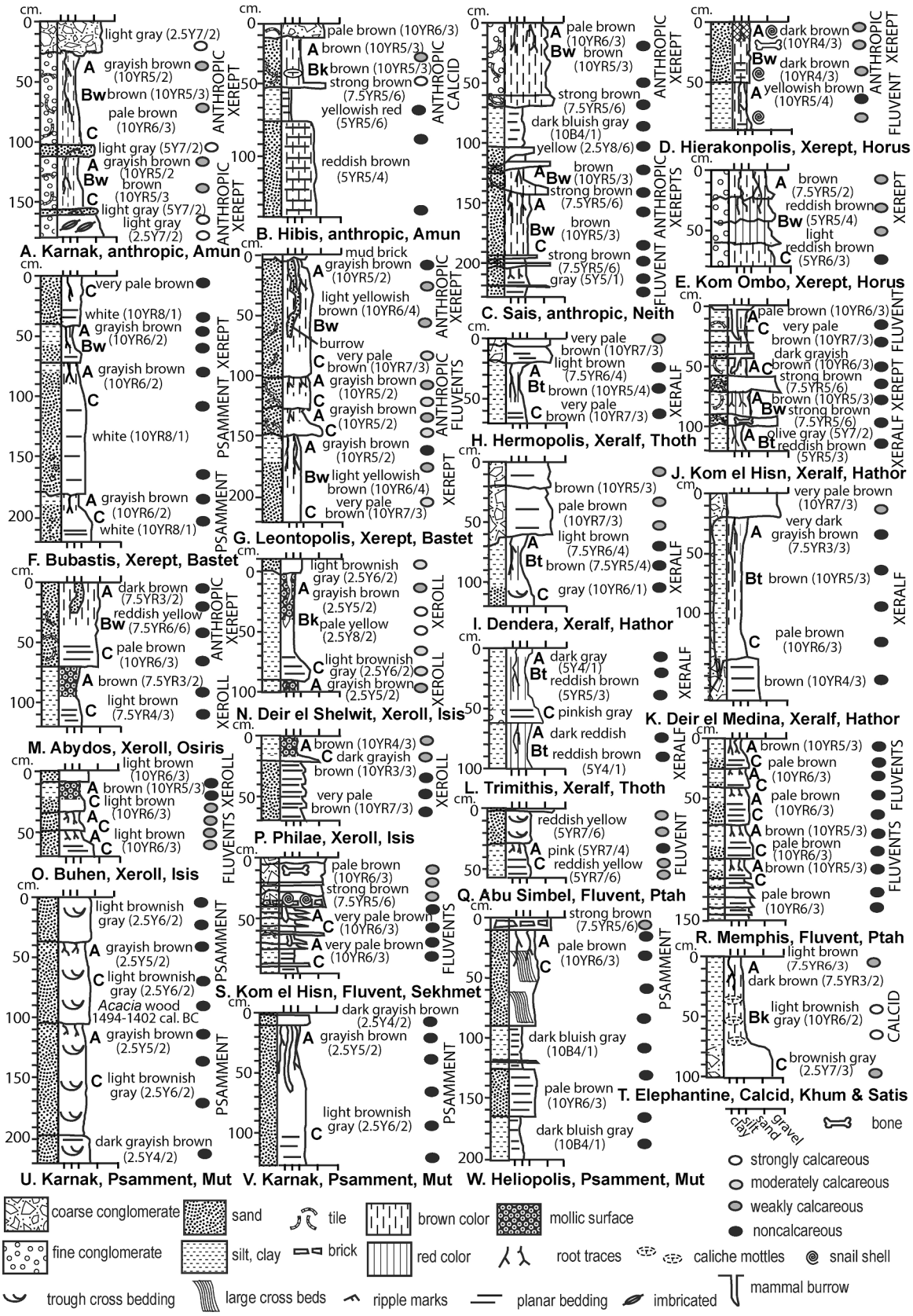

Fig. 4. *Measured sections of paleosols at Egyptian temples. Sources are listed in* Table 1.

Table 2
"*Paylands*" of Tanus in the Edfu temple creation myth.

Deities	Upper Egypt (long text, northern wall)	Lower Egypt (short text, pronaos)	USDA	FAO	Area in Egypt (km^2)	Area in Egypt (%)	Current use
Khnum, Satis	Place of the throne and building	Making the glories	Calcid	Xerosol	501,370	67.02	Hunting, gathering
Re, Nut	Island of Re, establishes Earth	(no equivalent)	Orthent	Lithosol	150,030	19.09	Retreat
Anubis, Anput	Underworld of the ba	Place of hiding	Natrargid	Solonchak	32,830	4.39	Salt pan
Ptah, Sekhmet	Born of water, prosperous seat	House of appearing	Fluvent	Fluvisol	31,560	4.22	Cultivation
Hapi, Sobek	Inundation of the earth, throne	Mansion of the seat	Aquent	Fluvisol	26,150	3.50	Fishing
Seth, Mut	High mound, high place	The first shrine	Psamment	Regosol	12,760	1.71	Hunting
Horus, Bastet	Mound of Radiant One	The great place	Xerept	Cambisol	7200	0.96	Hunting, tombs
Amun, Neith	High seat, destroying enemy	Place of piercing	anthropic	anthropic	543	0.072	Town and city
Osiris, Isis	Mound, powerful of ka	Beautiful of seats	Xeroll	Chernozem	53	0.0071	Farming
Thoth, Hathor	The seat on the mounds	(no equivalent)	Xeralf	Luvisol	0	0	Not available

Note: Payland terms are from translation of Finnestad (1985)*, not* Reymond (1969)*. Soil data are from* FAO (1977)*, but hard surface city area taken as 0.26 times major city land area from* Yin et al. (2005).

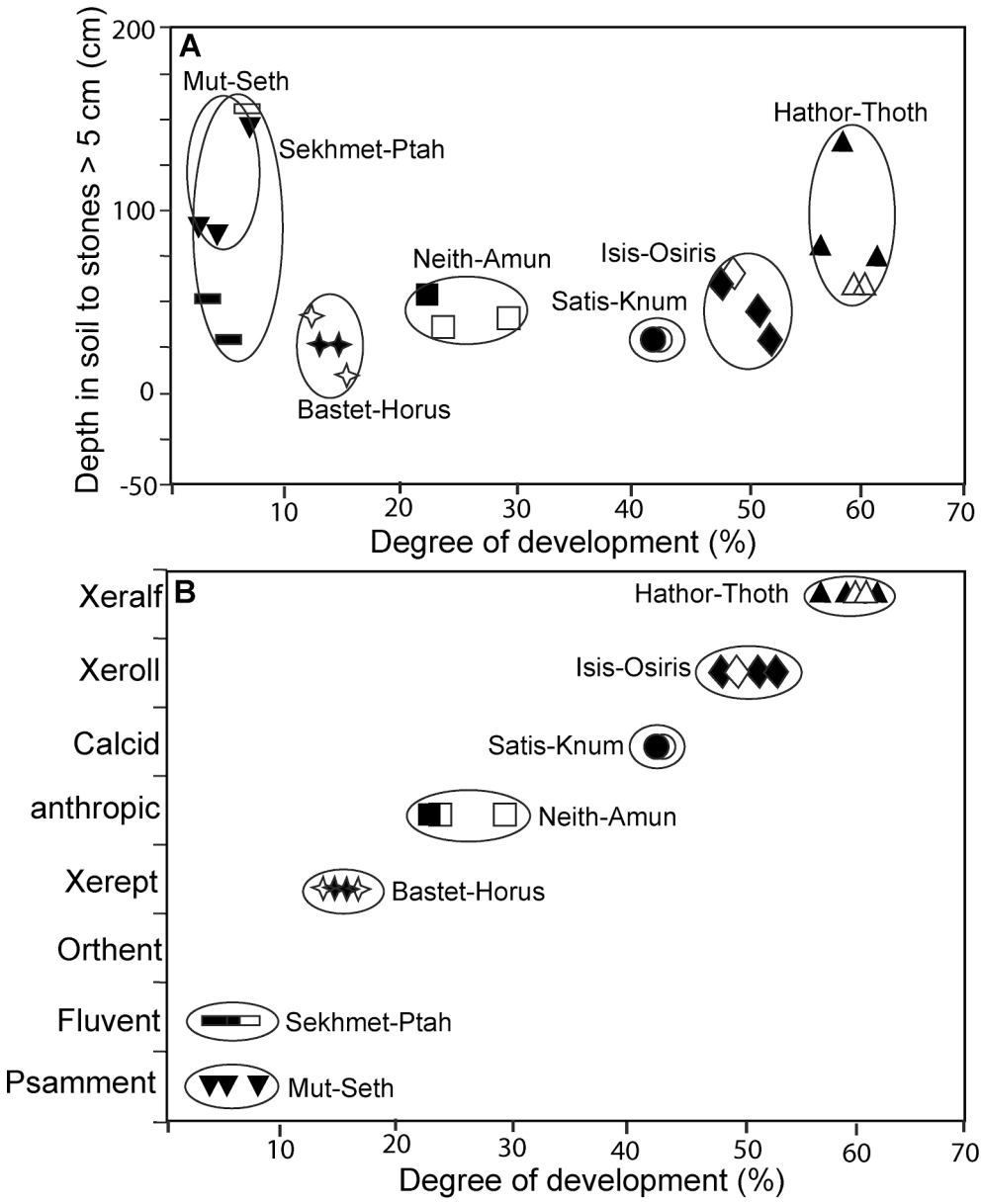

Fig. 5. Differences between 32 paleosols studied at the temples of Ancient Egypt showing depth to stones reflecting ease of ploughing, with negative depths for stones protruding from the ground. Degree of development is related to time available for soil formation (Retallack 2019b), and is also a consideration in soil classification (Soil Survey Staff, 2014); (b) sites related to types of soil and degree of soil development. Filled symbols are female and open symbols male deities, of the following pairs Amun-Neith (squares), Horus-Bastet (hexagons), Osiris-Isis (diamonds), Thoth-Hathor (triangles), Ptah-Sekhmet (rectangles), Knum-Satis (circles) and Seth-Mut (inverted triangles).

relict bedding (C horizon) from flood deposition (Fig. 3F).

Different kinds of paleosols were found at temples of different deities, but paleosols for the same deity were similar (Fig. 4), both in categories of stoniness (Fig. 5A) and of taxonomic orders (Fig. 5B). If there were no relationship, the deity envelopes in the morphospaces defined in Fig. 5 would be much broader and overlapping. These

categories are similar to soils at classical temples of Greece to the Olympian gods and goddesses (Retallack, 2008). The most important difference from Greek soils is the greater depth above plow-obstructing stones in Egyptian alluvial soils of Sekhmet and Ptah, and association of Mut and Seth with weakly developed sandy soils, rather than with rocky soils and caves. Soils of Bastet and Horus are Xerepts like soils of Neith and Amun, but the latter have prominent cultural debris, especially ceramic shards. Xerepts of Bastet and Horus are set apart from large towns, but those of Neith and Amun are within defensible tells. Only one soil was found at the temples of Satis and Khnum, which are side by side on Elephantine Island, and it was a Calcid developed on gravelly silt on Aswan granite bedrock. Xerolls are rare in Egypt now (Labib and Stoops, 1970), but were found at temples of Isis and Osiris. Xeralfs widespread as paleosols (Fig. 2A, 3A), but unknown in Egypt today (F.A.O.,1977), were found at temples of Hathor and Thoth.

5. Edfu inscriptions of sacred soils

Especially relevant to paleosols at ancient Egyptian temples is a text from the Ptolemaic (237 BCE) Temple of Horus at Edfu. This creation myth envisages emergence of the first mound from primeval waters, and then the subsequent emergence of eight or ten "*paylands*" of distinct kinds (Table 2). The "*payland*" division and subsequent temple consecration is attributed to Tanen, who was either a creator god (Finnestad 1985, p. 59), or a predynastic king (Reymond, 1969, p. 6). "*Payland*" ("*p'yw*" of Reymond, 1969; or "pcjw" of Finnestad, 1985) is "*the place in which the substances of the earth are endowed with special power*" (Reymond, 1969, p. 161), and "*sites needed for the foundation of sacred places which came to be the earliest sacred domains of the god, in which enclosures of gods were set up, and in which temples were built later on*" (Reymond, 1969, p. 93). A broader interpretation of "paylands" offered by Finnestad (1985, p.64) is simultaneous "*reference to the mythical topos, to the geography of Edfu, and to the temple of Edfu*". Like Reymond (1969), Finnestad (1985) acknowledges the prehistoric soil classification, but proposes also that the classification had ritual use for procession, recitation, and invocation, using a system of local stations around Edfu, and also within the temple precinct. The ritual of recreating the journey of Tanen though the primeval sacred soil geography of Egypt, may have been comparable with the Christian ritual of stations of the cross (McKenna, 2003). Finnestad (1985) came to this view from discovery of comparable names for localities around Edfu in ancient tax records, thus indicating that this cosmogeny was much more ancient than the current Ptolemaic temple. I have been unable to find a map of these local sites, but their detailed comparison with a local soil map of the Edfu region could be revealing.

The Edfu text also specifies rituals for temple establishment, along with temple design and size. The scheme of ten "*paylands*" on the inside of the northern enclosure wall at Edfu is for "*Wa'ret*", probably the area around Edfu, and the scheme of eight "*paylands*" near the pronaos is for "*Geswa'ret*", translated as "hinterland" (Reymond, 1969, p.19) or "edge of the water" (Finnestad, 1985, p. 43). The difference between the eight and ten "*payland*" version is lack of the high hill with stony soils and red woodland soils ("olive tree" of Reymond, 1969), which are recognizable as Orthent and Xeralf (Table 2). The eight "*payland*" version may be interpreted as Lower Egypt, and the ten "*payland*" version as the greater soil diversity of Upper Egypt. The modern areas and land use of these various kinds of soils in Egypt shown in Table 2 are from FAO (1977), but the estimate for Xeralfs is based on exposures of Omda Geosol in Upper Egypt (Butzer, 1966; Vermeersch, 2002). Areas of anthropic soils used the estimate for Cairo of Yin et al. (2005), with additions scaled similarly to the area of Luxor and Alexandria. This Edfu text can be regarded as the earliest known sacred and economic soil classification for Egypt, and Tanen ca. 5000 years ago as the father of soil science.

6. Discussion

The soil classification of "*paylands*" can in turn be related to distinct agricultural systems and social groups that they supported. The following paragraphs outline the different kinds of soils, and the earliest records of deities, cults, and castes on them. Ancient Egypt had a caste system, according to Herodotus (II-164, Holland, 2013). "*Now, the people of Egypt are divided up into seven social classes, each one named after a profession: one, for instance is called the priests ['ιρέες], another the warriors [μαχιμοι κεκλεαται], then there are the cowherds [βουκόλοι], the swineherds [συβωται], the tradesmen [καπηλοι], the interpreters ['ερμηνέες] and the steersman [κυβερνηται].*" These are broadly similar to the caste system of Hinduism in India, which recognized Brahmins (priests), Kshatriyas (warriors), Vaisyas (merchants), Sudras (laborers) and Ati Sudras (untouchables: Deshpande, 2001). Indian castes are hereditary, endogamous, and occupation-specific, resulting not only in economic disparities (Deshpande, 2001), but genetic differences (Lanchbury et al., 1996; Zerjal et al., 2007).

6.1. Paleosols of the warrior cult of Amun and Neith

Paleosols of Amun and Neith were littered with ceramic of long occupation of tells or other fortified positions, so were anthropic soils or Technosols (Fig. 4). These defenses were sacred sites of the warrior caste, "*those best prepared for war*" of Herodotus (II-164: Holland, 2013).

In the Pyramid Texts (ca 2350 BCE: PT1540 Mercer 1952) the pharaoh is described as occupying "*the throne of Amun*", and by the 12th dynasty (1991 BCE) Amun has epithets of "*king of the gods*", "*lord of victory*", and "*lover of strength*" (Wilkinson, 2003). New Kingdom pharaohs, Amenophis III (1391–1353 BCE) and Ramesses II (1290–1224) extended Egyptian borders by conquest, establishing temples to Amun as far afield as Abu Simbel and Sanam in the south, and Tanis (San el Hagar) in the north, as well as embellishing temples at Luxor and Karnak (Wilkinson, 2000).

Neith was the "*mistress of the bow*" and "*ruler of arrows*", first depicted on an ivory label from the burial site of King Aha (3100 BCE) as two end-to-end ovals and crossed arrows (Lesko, 1999). Her principal sacred site was Sais, a fortified tell in the delta (Wilkinson, 2000). Her festival involved defensive lamp lighting around houses, not only in Sais, but throughout Egypt (Herodotus II-59: Holland, 2013).

6.2. Paleosols of the hunter gatherer cults of Horus and Bastet

Temples of Horus and Bastet are on well drained rocky or hillside locations with limited soil development (Xerepts). Rocks and lack of surface water nearby limit their use for farming, so their main use was for subsistence hunting and gathering. Hunting became limited through time due to local extinctions of wildlife, including 20 of an original 37 large (>4 kg) mammals at the end of Old Kingdom (2150 BCE: Yeakel et al., 2014).

Hunter-gatherer soils are appropriate for Horus as perhaps the most ancient of Egyptian deities, preceded by other falcon deities shown on the Narmer palette (2920 BCE). The Turin Canon describes predynastic rulers of Egypt as "*followers of Horus*". Horus' later role as a visionary "*ruler of the sky*" and "*lord of heaven*" may have been a consequence of unification of varied tribes (Anthes, 1959). A Graeco-Roman (332 BCE to 395 CE) midsummer "Festival of the Beautiful Meeting" was a sacred visit of the image of Hathor from Dendera to the temple of Horus in Edfu, but they lived apart the rest of the year (Lesko, 1999; Wilkinson, 2000). Different traditions regard Hathor as wife, or as mother of Horus (Wilkinson, 2003).

Bastet was a lioness goddess of fearful anger, as well as mother and nurse for the pharaoh in the Pyramid texts (ca 2350 BCE: PT1111 of Mercer, 1952). By the 22nd dynasty (945 BCE) in her cult center of Bubastis, Bastet had evolved into a cat goddess, and patroness of women and pregnancy (Lesko, 1999). Herodotus (II-59) describes the festival of

Bastet as a pilgrimage to Bubastis on river barges, singing to castanets and flutes, and dancing, with stops at river towns along the way. Once at Bubastis they celebrated by "*offering up a prodigious number of animal blood-sacrifices, and by drinking more wine over the course of the festivities than is consumed over the whole rest of the year*" (Holland, 2013). Wine is known from jars and grape remains as old as the first dynasty (2920 BCE) at Abydos and Saqqara (Katary, 2013; Samorini, 2019).

6.3. Paleosols of the pastoral cults of Thoth and Hathor

Soils at temples of Thoth and Hathor are red, well drained and clayey (Xeralfs) of dry woodlands (Fig. 4). Xeralfs are unreported in Egypt currently, but formed in Upper Egypt before mid-Holocene climatic aridification (Figs. 2, 3A) as the Omda Geosol of Butzer (1966). They were rare in Egypt and most valuable for tree crops or rough grazing.

In the Pyramid Texts (ca 2350 BCE; PT128 of Mercer, 1952), Thoth is described as one of the companions of Re (the sun), and also travels across the sky, perhaps as a lunar god. Thoth was identified iconographically with the sacred ibis, and also with baboons, as a "*peace maker*", "*writer of truth*" and "*lord of the laws*" (Wilkinson, 2003). His role as god of wisdom and learning, as explained by Plutarch, was because of ibis's predation of harmful reptiles and avoidance of water unsafe to drink (Bleeker, 1973).

Association of the water-loving ibis with cow-headed Hathor may have come from papyrus marshes, where the goddess is depicted in some of her earliest images for Khufu's mother Hetepheres (ca. 2551 BCE) and for Menkaure (2490 BCE: Bleeker, 1973). In texts of a 5th dynasty (ca. 2400 BCE) tomb at South Abusir, Hathor was "*mistress of the sycomore*" (Strudwick, 2005), meaning the fig tree *Ficus sycomorus*, not American sycamore (*Platanus occidentalis*). Hathor's first temples included 3rd dynasty (2649 BCE) Gebelein, and 4th dynasty (2575 BCE) Dendera (Lesko, 1999). At Dendera, she was "*mistress of the viands*", "*mistress of the sky*", "*queen of the stars*", "*eye of Re*" and "*mistress of the book*" (Bleeker, 1973). In a chapel of the mortuary temple of Hatshepsut at Deir el Bahri (1473 BCE) Hathor was "*mistress of the vulva*", a goddess of love and birth (Bleeker, 1973). At Dendera she had an annual festival of sacred intoxication (Myśliwiec, 2004).

6.4. Paleosols of the tradesman cult of Ptah and Sekhmet

Paleosols at temples of Ptah and Sekhmet were alluvial soils (Fluvents) of the Nile River floodplain suitable for irrigation works and large agricultural estates. These soils are similar to those of the other great alluvial civilizations of the Middle East and India (Hillel, 1992). In Egypt, large agricultural estates belonged to pharaohs, priests, generals, viziers, and other bureaucrats (Wilkinson, 2003). Not only staple grains, but fruits, vegetables, vines, and ornamental plants were cultivated on estates (Katary, 2013). Corporate agriculture is even now different from family farms (Hanson, 1995).

Ptah appears in the Pyramid Texts (ca 2350 BCE PT573 of Mercer 1952), and in art from the 1st dynasty (2020 BCE; Janick, 2002). During the Old Kingdom construction of the great pyramids he became known as a craftsman with a large temple complex in nearby Memphis (Wilkinson, 2003). With royal favor, skilled craftsmen became merchants and landholders of consequence (Katary, 2013).

Sekhmet was one of several lion-headed goddesses (Lesko, 1999), and also a manifestation of the sun as the Eye of Re and mother of the king in the Pyramid Texts (PT262, 2400–2300 BCE). Sekhmet was said to be able to breathe fire against her enemies, and the hot desert winds were called the "*breath of Sekhmet*". She also brought plagues as "*slaughterers of Sekhmet*". Pharaohs sought her favor in war, but generally Sekhmet was a healing deity, and her worship included spells and charms against illness (Wilkinson, 2003).

6.5. Paleosols of the agrarian cult of Osiris and Isis

Temples of Osiris and Isis are on grassland paleosols with crumb structure (Mollisols) suitable for mixed farming of grain, vines, and grazing on small holdings. Only 3 arouras (about 24.6 ha: Baer, 1956) was an area capable of supporting a family in the New Kingdom according to the Ramesside Wilbour Papyrus (Katary, 2013). The curious nickname of "*swineherds*" given by Herodotus for a social caste, may have been family farmers, as explained by another passage; "*those who live there… wait for the river to rise of its own accord, and inundate their fields, after which, once the waters have done their work of irrigation and retreated, each man will sow his own plot: then pigs are released into the fields to ensure that the seed is trodden down.*" Herodotus II-14: Holland, 2013). This method on small plots, supplemented hoeing or plowing with oxen or donkeys, evident from Egyptian art back to 1900 BCE (Janick, 2002; Katary, 2013). "*The pig is thought by the Egyptian to be an unclean animal….Nor is anyone prepared to give his daughter in marriage to a swineherd, nor receive the daughter of one into his own household: swineherds, as a result marry off their daughters to one another*" (Herodotus II-47: Holland, 2013). With declining esteem of pigs from the Old to Middle Kingdom (Redding 1991), "*swineherds*" became a term for low caste farmers.

Osiris is frequently mentioned in the Pyramid Texts (ca. 2350 BCE, PT10, 23–25 of Mercer 1952), and Plutarch claimed that he was a prehistoric Egyptian king (Wilkinson, 2003). By the second half of the 6th dynasty (2255 BCE), Osiris emerged as dying god, killed and resurrected like the crops he represented (Lesko, 1999). In addition to popular corn mummies of earth and grain which sprouted from the image of the god, worship of Osiris also included exclusive ceremonies, called mysteries (Wilkinson, 2003), perhaps similar to Eleusinian mysteries of Ancient Greece (Retallack, 2008).

Isis appears in the Pyramid Texts (ca 2350 BCE) assisting the deceased pharaoh, but emerged in the 6th dynasty, with the essential duty of reassembling the dismembered Osiris. Isis was "*great of magic*", and emblematic of marital devotion and motherhood, and knowledgeable about funerary practices and religion. Her sacred symbol, the tyet, was a folded cloth rendered in red semiprecious stone or painted red (Lesko, 1999).

6.6. Paleosols of the sailor cult of Khnum and Satis

Paleosols at the temples of Khnum and Satis are calcareous desert soils (Calcids) on rocky islands and high terraces of the Nile cataracts. They have little agricultural utility because dry and salty, but the cataracts control commerce on different parts of the river. These may have been soils of sailors or boatmen of the Nile, the "*steersman*" lower caste of Herodotus (II-164: Holland, 2013).

The principal river deities were ram–headed Khnum and his consort antelope-horned Satis, whose temples are side by side on the Upper Egypt island of Elephantine. Khnum had been worshipped there since predynastic times (Wilkinson, 2003). Khnum was also a creator god, depicted forming pharoahs from Nile clay on a potter's wheel in temples at Esna and Karnak (Myśliwiec, 2004). Satis is first mentioned in the Pyramid texts (2400–2300 BCE) purifying the king with four jars of water from Elephantine (Mercer, 1952).

6.7. Paleosols of the marsh-dweller cult of Seth and Mut

Temples of Seth and Mut are weakly developed dune paleosols (Psamments) near Nile channels and marshes. This may be the setting of the most puzzling of the lower social castes nicknamed by Herodotus (II-164: Holland, 2013) as "*interpreters*", which could be taken as laborers, opportunists, or drifters of marginal lands. "*And now a second time he [Psammetichus] had been forced into exile, even though he was king, driven into the marshes…*" (Herodotus II-52: Holland, 2013). Bedouin nomads of the desert, marsh dwelling fisherman of the delta, and pirates ("sea peoples") were generally regarded as beyond the pale of Egyptian

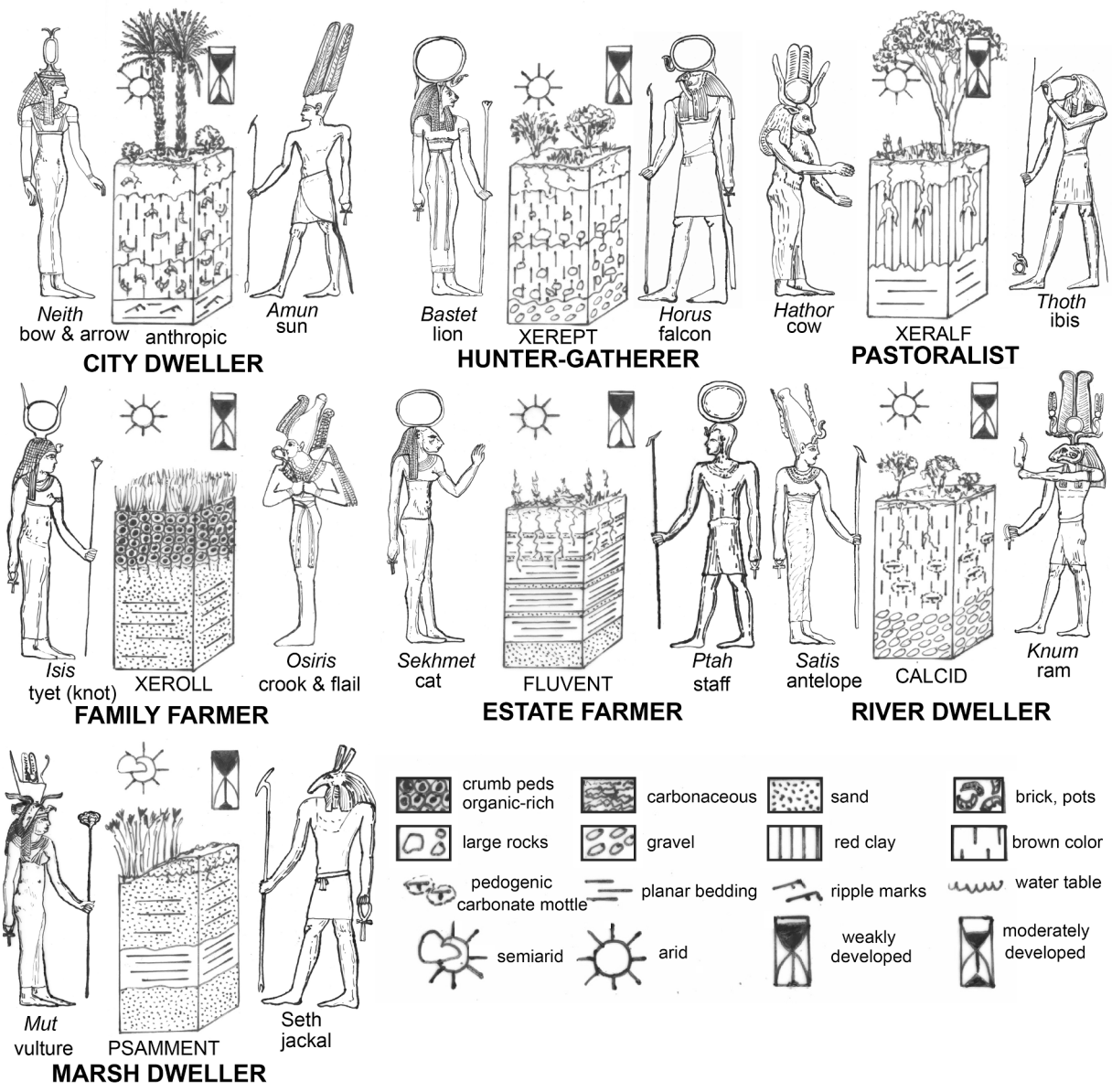

Fig. 6. Cartoons of soils and deities of Ancient Egypt.

civilization (Brewer and Teeter, 1999).

Jackal-headed Seth is recognizable back to predynastic times from an ivory artefact of the (Naquada I Period (4000–3500 BCE), and was originally a desert deity (Wilkinson, 2003). As a god of violence and confusion he was cast as the villain in the 6th dynasty (2255 BCE), cult of Isis and Osiris (Lesko, 1999). During the Second Intermediate Period (1640–1532 BCE) Seth was worshipped by Hyksos occupiers as the closest Egyptian deity to Baal of their homeland. Rituals associated with Seth included animal sacrifices of ox, hippopotamus, and "strangling the desert bird" (Wilkinson, 2003).

Mut is the Egyptian word for mother, but written with the hieroglyphic sign of the vulture, which often appears in her headdress. Mut does not appear until the Second Intermediate Period of Hyksos occupation (Lesko, 1999). Her best-known temple was built by Amenophis III (1391 BCE) a few hundred meters south of the great temple of Amun at Karnak (Wilkinson, 2000). Her rituals included lake navigation festivals, destruction of images of enemies, and a temple oracle (Wilkinson, 2003).

7. Other explanations for Egyptian temple location

The most impressive temples of Ancient Egypt, such as Edfu and Philae, were renovated by Graeco-Roman pharaohs long after they were established (Wilkinson, 2000), so how representative of Old to New Kingdom religion are the temples available for study? The Macedonian Ptolemy I Soter, who founded that line of pharaohs, had a political interest in rekindling Egyptian nationalism through authentic restoration of the old temples (Pollard and Reid, 2007). While important sites have been lost, such as the shrine of Aphrodite at Atarbechis (Herodotus II-41: Holland, 2013), most of the temples studied here were mentioned in Old Kingdom Pyramid texts (ca 2350 BCE: Mercer, 1952).

The temple of Amun at Gebel Barkal is famous for a rock formation in the nearby cliff that looks like a uraeus, or rearing cobra (Wilkinson, 2000). Were similar rock formations the reason for placement of other temples? Memphis, Luxor, and most of the Nile Delta sites are in flat floodplains with little scenic distinction, unlike the striking scenery of the Giza Plateau (Butzer et al., 2013) and Valley of the Kings (Aubry et al., 2009), which are funerary complexes not considered here.

Much has been made of the astronomical alignment of Old Kingdom

pyramids and their associated mortuary temples (Waziry, 2016), so were they sited on astronomical axes? There is evidence that many temples and other structures were oriented toward the sun and stars, particularly Sirius (Shaltout et al., 2007; Belmonte, 2015). The actual orientations are scattered because the date of construction varied at dates up to a quarter of an astronomical precession cycle removed from our times (Shaltout et al., 2007). These considerations may have ruled temple orientation, but the dispersed clusters of sites show no overarching astronomical distribution (Fig. 1).

Numerous temples for Amun were constructed by Ramesses II (1290–1224 BCE), especially in what is now northern Sudan (Table 1), so can the location of temples be regarded as the whims of individuals and accidents of history? Ramesses had a political agenda to secure the Nubian border, just as Amenophis III (1391–1353 BCE) had a political agenda to remake Luxor Temple about his birth and rule (Wilkinson, 2010), but the sites themselves are much more ancient according to the Edfu texts (Reymond, 1969; Finnestad, 1985).

8. Interpretatio Graeca

Although much has been made of equivalences of ancient Egyptian and Greek gods, widely known as *Interpretatio Graeca*, there are a variety of reasons to urge caution against such motivated reasoning: notably religious changes over three millennia, syncretism, and political manipulation, especially in Ptolemaic times (Lesko, 1999). Nevertheless, during his pre-Ptolemaic visit in about 450 BCE, Herodotus concluded that Dionysos was Osiris (II-42; Holland, 2013), Apollo was Horus (II-144, 156), Artemis was Bastet (II-137, 156), Demeter was Isis (II-59. 156), Zeus was Amun (II-2), and Pan was Mendes (II-46). His lack of identification of other gods has been lamented (Lattimore, 1939), but some can be inferred from his account of the main temples to gods named in Greek, such as Hephaestos in Memphis (II-2, II-3, II-101, II-110, II-112, II-121), at the main temple of Ptah (Wilkinson, 2000). The principal festival for Athena was in Sais (II-59), where the main temple was dedicated to Neith (Wilkinson, 2000). Herodotus places the main temple of Aphrodite at Atarbekhis in the delta (II-41), perhaps an early temple to the Greek rather than Egyptian goddess, like temples at nearby Athribis and Naukratis (Wilkinson, 2000). This leaves uncertain the Egyptian equivalents of Roman "*Mercury*" and "*Vesta*" mentioned by Diodorus Siculus (II-5, Booth, 1721). Greek Hades, Persephone and Poseidon are not mentioned by either classical tourist.

The remaining uncertain deities are cow-headed Hathor, ibis-headed Thoth, cat-headed Sekhmet, antelope-horned Satis, ram-headed Knum, vulture-loving Mut, and jackal-headed Seth. The iconography of death for Mut and Seth are suggestive of a role like that of Persephone and Hades. The domestic cat iconography of Sekhmet is a match for Hestia (Wilkinson, 2003; Myśliwiec, 2004). The principal temples of Thoth were at Hermopolis Magna (El Ashmunein) and Hermopolis Parva (El Baqliya), so that by Ptolemaic times, Thoth was equated with those towns' namesake, Hermes. Khnum and Satis were husband and wife with names etymologically linked to the flow of the Nile, only tenuously similar to maritime deities Poseidon and Aphrodite. The tempestuous maritime gods Aphrodite and Poseidon (Retallack, 2008) did not quite register with the ancient Egyptian mindset, focused on the great steady river. By Ptolemaic times, the towns of Gebelein and Atfih, with important Hathor temples, were both renamed Aphroditopolis, identifying Hathor with Aphrodite (Wilkinson, 2003). The hybrid goddess Isis-Aphrodite also became popular during Graeco-Roman times (Wilkinson, 2003). Both Hathor and Satis have been regarded as Aphrodite or Hera (Wilkinson, 1851). Egyptian confusion concerning the Greek goddess Aphrodite is the most compelling evidence to resist a fusion of Egyptian and Greek pantheon, and may reflect cultural differences in sexual mores.

9. Conclusions

As for Ancient Greek, Palestinian, Indian, and Chinese temples (Kramrisch and Burnier, 1976; Winiwarter and Blum, 2006; Retallack, 2008, 2019a), temples of Ancient Egypt also were sited on soils suitable for their cult. The complexity and number of deities in Ancient Egypt is far in excess of Greek religion (Wilkinson, 2003). There are also physical differences, such as less rocky and deeper soils of Egypt compared with soils of Greece. Nevertheless, this study supports the view of Herodotus (II:2; Holland, 2013) that "*the Egyptians were the first to use the names of the twelve gods, and that these were then adapted from them by the Greeks*". Some soils such as Xerepts are better suited to hunter-gatherer ways and priestly social classes of Bastet and Horus, whereas other soils such as Xeralfs are better suited to pastoralist lifestyles and the cowherd social class of Hathor and Thoth (Fig. 6). Religious sensibilities, rituals and calendars are shaped by lifestyle allowed by local soil resources. Hieroglyphic texts at the temple of Edfu outline a soil and land use classification of "*paylands*" at the origin of the world from the great flood, and these paleosols are recognizable in archeological excavations (Fig. 1). All but Xeralfs are still found in Egypt today (Table 2). The author of this "*payland*" classification was predynastic (5 ka) ruler, also regarded as a demigod, Tanen (Reymond, 1969; Finnestad, 1985), who deserves wider recognition as a pioneer of soil science.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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