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The Pharaoh's Curse: New Evidence of Unusual Deaths Associated With Ancient Egyptian Tombs

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HIGHLIGHTS

The Pharaoh's Curse written on some Egyptian tombs might have warned against mysterious deaths that actually trace to radiation poisoning.

ABSTRACT

A survey of modern-era field Egyptologists reveals a very high incidence of unusual deaths consistent with symptoms of haematopoietic cancer, a scenario that parallels radiation sickness caused by exposure to abnormally high radiation previously reported in ancient tombs. However, the high radiation in tombs is not explained by the 'natural' background, which is rare in limestone bedrock. Here, re-examination of Egyptian funerary literature reveals reference to saffron cake in portions of 2-3-5 (yellowcake U-235), giving power by means of an invisible 'efflux', and leaving a legacy of hazardous 'excrements' (wastes) which were buried in an underground 'tomb' called the *per D'jet* (house of millions of years). The ancient curse warned that those who break this tomb shall meet death by a disease that no doctor can diagnose.

KEYWORDS

Ancient Egyptian tombs, cancer, mastaba, Pharaoh's Curse, radiation sickness, Tut's tomb, unusual deaths, yellowcake.

INTRODUCTION

Both contemporary and ancient Egypt populations are characterised by unusually high incidence of haematopoietic cancers, of bone/blood/lymph, for which a primary known cause is radiation exposure. In recent years, the popular mythology of the Pharaoh's Curse has been associated solely with the discovery of Tutankhamun's tomb in 1922, following which the exploration sponsor, Lord Carnarvon, died unusually within a few weeks. But the history of the curse is very much older, going back to the early Old Kingdom from ca. 3000 BCE. In ancient Egypt, the 'tomb' itself was called the *pr D'jt* (*per D'jet*), meaning the 'house of eternity' (literally 'millions of years'), and was characterised in religious terms as sacred or sacrosanct (unapproachable). That ancient knowledge passed into modern Arabic folklore, where early European archaeologists recorded that the ruins were still called *Haram el-Mastabat* (forbidden, prohibited mastaba), and local guides refused to approach because of fear of *illahat* (evil spirits). (Budge, 1904, pp. 14-15)

The nature of the curse was explicitly inscribed on some tombs, with one translated presciently as, "they that break this tomb shall meet death by a disease that no doctor can diagnose" (Hawass, 2000, pp. 94-97). The age-old curse was recognised by modern-era archaeologists. British Egyptologist Arthur Weigall, a rival of Howard Car-

ter in excavations around Thebes, watched an exultant Carnarvon (with Carter) enter Tut's tomb and remarked to a colleague, "he will be dead within six weeks." (Nelson, 2002, pp. 1482-1484). Ironically, Carnarvon *was* dead within a few weeks of the uncertain diagnosis of blood poisoning and pneumonia, while Weigall died prematurely at 54 of cancer, and Carter died later at 65 of Hodgkin's lymphoma.

Despite the long known history of 'the curse,' it was not taken seriously by early Egyptologists. At the height of the romance of Egyptomania, the popular press made extravagant claims for the malevolent spirits of Tut's tomb, but orthodox Egyptologists were scornful. Carter scoffed, "all sane people should dismiss such inventions with contempt." (Nelson, 2002, pp. 1482-1484). Nevertheless, he was fearful enough to take swabs of the sarcophagus and samples of air, but all were sterile. Despite his scorn, Carter was careful to run tests within the limits of the knowledge and technology available in 1922.

Now, recent studies have revealed that the ancient tombs are strongly radioactive, and here it is shown that Egyptologists who explored the tombs have suffered a high incidence of haematopoietic cancer and related symptoms of what is recognised as radiation sickness. Including Carter, who died of Hodgkin's lymphoma.

Summary of an Unorthodox Hypothesis

This study presents a sequence of related observations that lead to an unorthodox conclusion:

- Ancient Egypt exhibited an unusual incidence of cancer and of undefined 'poisoning', attributed (in translation) to famine, plague, or evil spirits.
- Modern studies confirm very high levels of radiation in ancient Egyptian tombs, in the order of 10x accepted safety standards.
- Here, a survey of field Egyptologists who worked in the tombs reveals a very high incidence of cancer, cardiovascular failure, and other sudden/unusual deaths with symptoms characteristic of radiation sickness.
- Reported strong radiation (as radon) in tomb ruins has been loosely attributed to the natural background from the parent bedrock. However, the levels are unusually high and localised, which is not consistent with the characteristics of the limestone bedrock but implies some other unnatural source(s).
- Examination of Egyptian funerary literature reveals explicit reference to the transformation of Osiris by the efflux of yellowcake-235 (U_{235}) and the burial of the hazardous excrements (wastes).
- Textual and archaeological evidence of the tombs presents a wide range of features that correspond closely in detail to modern principles of underground storage of long-life radioactive nuclear waste. The burial vaults were called *per D'jet,* meaning secure underground house of millions of years, described as sacred or sacrosanct (unapproachable); which passed into modern Arabic as *Haram el-Mastabat*, forbidden, prohibited mastaba because of *illahat* (evil spirits).

These observations present evidence that, at a stage in ancient Egyptian history ca 3000-2500 BCE, there were vaults [bunkers] with features and residual effects (of radioactivity) indicating deliberate, organised burial of long-life nuclear wastes. No commentary is offered on the who, how, and why questions relating to the implied technology, which is outside the scope of this paper.

This hypothesis is quite unorthodox and contrary to perceived views of ancient Egyptian history, but it is sufficiently supported to warrant further direct investigation.

Cancer In Contemporary Egypt

The general population of modern Egypt exhibits high rates of cancer. A 1999-2005 study in the Delta showed the incidence of haematopoietic cancers [HC] was much higher than in adjacent comparable countries (Herzog et al, 2012, pp. 2748-2755). A wider national study for 2008-2011 indicated the total rate for all cancers is higher than expected, intermediate between more and less developed countries, within which HCs were ranked at #5, which is much higher than the world average (Ibrahim et al, 2014, pp. 437-971). The high incidence of HC in present-day Egypt has been loosely blamed on modern lifestyle factors such as diet and industrial pollutants. But that view has been firmly rebutted by evidence from ancient Egypt (Faltas, 2011, p. 76). The primary known cause of haematopoietic cancers is radiation exposure, and some Egyptian dwellings are known to exhibit high levels of radon, ranging up to 220 Bq/m^3, which is above the maximum levels recommended by ICRP, USEPA, and WHO (Arafat et al., 2018, pp. 147-156).

Cancer In Ancient Egypt

Several modern forensic studies confirm an unexpectedly high incidence of haematopoietic cancers (HC) in ancient Egypt (Binder et al, 2014; Faltas, 2011; Lovell & Whyte, 1999; Mant, 2014; Pahl, 1986; University of Grenada, 2017; Zink, 1999). Studies of skeletons from various sites and periods have revealed examples of multiple osteolytic lesions of myeloma, degenerative joint disease, cranial porosity, and nasopharyngeal carcinoma at rates

much higher than in modern populations. Faltas (2011, p. 76) pointed out that this data firmly refutes popular claims that HC is solely a modern disease. Some authors assert that the incidence of bone porosity *must have been* due to famine, but Egyptian texts (below) make it clear that the 'plague' was not caused by a famine but described as the burning power of magic spells released by senseless people. Incidence of internal blood or digestive system ailments was recognised in ancient medical texts, which featured remedies for casting out evils of the blood and for treating 'corruption' (Egyptian: *whwd*) characterised by weakness of the flesh, wasting away, diarrhoea, passing blood and putrefaction - attributed to malevolence of evil spirits (Ritner, 2000, pp. 107-117; Unger, 2020, pp. 123-138). The high incidence of (fatal) HC is also consistent with the records of hundreds of 'retainers' (workers) at Abydos who appeared to be sacrificed by poisoning (Recht, 2020, pp. 168-180), which is consistent with records of the 'plague', and consistent with the enormous resources expended by Djoser to relocate 40,000 pots from Abydos to Saqqara (Fritschy, 2018, pp. 161-176). Djoser was later commemorated for saving the country from plague, and elsewhere, the ancient text of the *Lamentations of Ipuwer* recorded a time when - plague stalked the land; a burning power went forth; women, beasts, and crops were barren; we know not what happened; all goeth to ruin; mankind is destroyed. A few senseless people divulged the magic spells of the cursed inaccessible place, the secrets of the lords whose limits were unknown (Erman, 1923, pp. 92-108).

Memory of the 'magic burning power' was preserved in Egyptian language as the *t³-dsr* (cleared, isolated) area surrounding the *per D'jet* underground storage vault, which passed down the generations into Arabic *Haram el-Mastabat,* the forbidden, prohibited tomb containing *illahat* evil spirits.

Cancer In Modern-Era Egyptologists

The association of HC with ancient tombs prompts examination of the death records of modern-era Egyptologists and their associates, many of whom spent years excavating tombs. This study presents records of 505 field Egyptologists and associates who were active explorers, excavators, scholars, illustrators, collectors, curators, and traders of tomb ruins and artefacts in Egypt, mainly in the period 1800-2000. The occupations are not mutually exclusive; many prominent excavators were also collectors and later curators. Petrie is revered as a pioneering scientific excavator, but he also collected thousands of antiquities which are now in the museum at University College London; Carter is known for discovering Tut's tomb, but he was later a collector and trader and was found to have illicitly kept several items from Tut's tomb; Henry Salt was nominally British Consul, but collected voraciously for the British, Ashmolean and Bodleian museums. The list also does not include the local workers who were directly engaged in primary excavations, nor the many unknown tomb robbers engaged by unscrupulous traders.

The data set is not amenable to formal statistical analysis for several reasons. The records of potential exposure are incomplete and not quantified; records of cause of death are anecdotal, not forensic; and there is no practicable means of establishing a baseline unexposed cohort for comparative analysis. The observations that follow are, therefore, largely indicative rather than statistically significant in the usual sense.

The first impression of the data set is that it presents a picture of many early, untimely deaths and a range of other sudden/unexpected deaths from poorly defined causes. Examples include many iconic names from early Egyptology. Belzoni, the archetype 'tomb raider' died at 45 of nominal 'dysentery'; Champollion, of hieroglyph translation fame, spent 1828-29 studying texts inside the pyramids at Saqqara, then died in 1932 at age 41 of 'exhaustion and apoplexy' (along with five of his companions); Rosellini, father of Italian Egyptology and associate of both Belzoni and Champollion, died at just 43 of 'suspected malaria'; Mariette, pioneering excavator at Saqqara, suffered illness and near-blindness before collapsing of violent haemorrhage and dying at 59; his successor, Maspero, retired early due to ill-health and collapsed and died at an academic seminar, aged 70; prominent British Egyptologist W. Emery spent many years excavating at Abydos and Saqqara until he collapsed inside a tomb at Saqqara and died within two days, labelled as 'stroke'; American G. Reisner spent years excavating the Giza mastabas, then at age 75 he collapsed inside the Great Pyramid and died of 'suspected poisoning'; another notable American, J. H. Breasted, on return from Egypt to NY collapsed and died of suspected strep infection possibly complicated by malaria; Lord Carnarvon at age 56, within weeks of opening Tut's tomb, suffered a mosquito bite that caused infection that led to strep poisoning that led to pneumonia and death; while Carter himself died later at age 65 of Hodgkin's lymphoma. Another curious example, possibly tangential, was the case of Napoleon, who led a military/scientific expedition to Egypt in 1798-1801, during which he explored ruins and (allegedly) slept overnight inside the Great Pyramid. He died at just 51 after suffering months of illness, nausea, vomiting, abdominal pain, and blood clots; diagnosed by autopsy as stomach cancer and since validated (Lugli et al., 2007, pp. 52-57).

These deaths, and many others detailed below, oc-

curred separately at different times and places without presenting a noticeable pattern. An excellent compilation of Egyptologists' biographies is available in *Who Was Who in Egyptology* (Bierbrier, 2012), but mostly without any details of the cause of death (COD). The survey here of 505 records, including COD, is derived from a range of public sources, including newspaper obituaries and tributes in Egyptology journals.

The exact cause of death was frequently not reported at all or was related anecdotally on the basis of general symptoms rather than on forensic examination. In early cases, the determination of COD may have been limited by the facilities of the time and place and was often characterised euphemistically as unfortunate ill-health and untimely death attributed to the harsh working conditions of excavations in Egypt. Of the total 505 records of active field Egyptologists, there were 119 cases of recorded sudden/unexpected/uncertain deaths, characterised by collapse, short illness and death, attributed to cancer or heart/stroke, or to general illness associated with gastro-intestinal effects, cardio-cerebro vascular effects, pulmonary/respiratory effects, and a range of secondary infections variously blamed on poisoning or exotic diseases. There is a sense in the early records that sudden unexplained deaths may have been conveniently labelled rather than diagnosed. Sudden collapse and death were labelled apoplexy, heart attack, or stroke; evident blood disorders were labelled as poisoning due to strep infections, possibly complicated by diabetes or malaria (or other exotic diseases), which were the recognised issues of the period. The concept of HC was not known; leukemia was not defined until the mid-1800s, and lymphoma was not defined until the very late 1800s and not routinely diagnosed until much later.

Age At Death

Of the total 119 cases of recorded sudden/unusual/uncertain death, the average age was 60, versus an expected level of 60-70 for Western Europeans of that age group and period. Similarly, Nelson (2002), in an analysis of individuals present at the opening of Tut's tomb, showed an average age-at-death of 70 versus 75 for an unexposed control group. Those observations suggest a trend toward lower life expectancy for field Egyptologists, but not substantially so. Modern studies show that radiation effects have a widely variable latency period (Seibold et al, 2020, pp. 324-399).

Cause Of Death (Appendix)

Recorded causes (or nominal labels) fall into four categories:

[1] 17 cases of cancer, including three of haematopoietic cancer (HC). That incidence of 3.4% is at least 10 times the current expected rate in Western EU countries. (WCRF, 2021)

[2] 19 cases nominally attributed to apoplexy/heart attack/stroke; taken at face value, an incidence of 3.8%, which is over 10X the current expected rate in western EU countries (less historically).

[3] a further 55 cases (11%) attributed loosely to 'illness', characterised as respiratory issues (pneumonia), blood poisoning, haemorrhage, diabetes, disease (malaria, cholera, typhus, plague), fever, dysentery or even insanity.

[4] another 28 cases recorded as sudden/unexpected death, but undiagnosed.

In the remaining 386 cases, the COD is unknown or inaccessible but included 52 instances of abrupt early deaths (<50 years).

While some individual cases may be unreliable or merely coincidental, the collective weight of numbers is strongly indicative of an unusual profile of deaths specifically to cancer, nominal heart/stroke, or vaguely to 'illness'. The rates of cancer (3.4%) and nominal heart/stroke (3.8%) are in the order of 10X the expected baseline rates for Western Europeans (less historically and less in undeveloped countries).

Particular Sub-Clusters

The Franco-Tuscan Expedition. Champollion's expedition of 1928-29 spent months studying the *Pyramid Texts* inside the pyramids at Saqqara, following which six team members met early, unusual deaths; Champollion (of hieroglyph fame) at 41 of exhaustion/apoplexy; Bertin at 29, unknown; Rosellini at 43 of 'malaria'; L'Hote at 38, of frail health; Ricci at 39, attributed to infection from a scorpion sting; and Lenormant at 57, of fever.

Collectors/traders. There is a suspicion of linkage to the handling of Egyptian artefacts among the early tomb robbers and traders, several of whom met early deaths. Ballerini died at 33; Ricci at 39; Belzoni at 45 (of 'dysentery'); Salt died in Egypt at 47 after collecting extensively for British museums; Lebolo at 49 and D'Athansi at 56, were both noted collector/traders; Carter died at 65 of lymphoma after collecting widely, including items taken improperly from Tut's tomb; and Drovetti died at 76 in an insane asylum.

Illustrators. There were 34 individuals listed as illustrators who might have been expected to spend long hours inside tombs copying inscriptions and murals.

Many met very early deaths (30-40), and the average age at death was 55.5, versus a total group average of 60 and an expected European average of 60-70. Reported COD included one case of leukemia (A. Quibell) and other characteristic cases ascribed to poisoning (Ricci), diabetes (Burton), and variations of illness/pneumonia/stroke (Firth, Jones, Legrain, H. Petrie)

Tut's tomb. Despite the scepticism relating to Tut's tomb, it remains intriguing that a number of those associated (before, during, and after) died unusually. Carter himself died at 65 of lymphoma; Carnarvon at 56 of blood poisoning; Bethell at 46 of asphyxia; Lythgoe at 65 of cerebrovascular disease; Burton at 60 of diabetes; Lucas at 78 of heart failure; Gould at 59 of fever and pneumonia; Mace at 53 of uncertain poisoning/pneumonia; Breasted at 70 of strep infection/malaria; and Reid at 53, ironically of X-ray exposure (possibly pre-existing). Weigall was an independent excavator and later journalist at the opening of Tut's tomb, where he was accused of inciting the 'myth' of the curse. Ironically, he died early at 54 of cancer.

Overall, this data set of modern-era field Egyptologists and associates known to have been exposed to ancient tombs reveals a pattern of strongly elevated incidence of sudden/untimely/unusual deaths accompanied by symptoms characteristic of underlying haematopoietic cancer caused by exposure to ionising radiation. This syndrome is now recognised as radiation sickness (or poisoning) and affects the hematologic, gastrointestinal, cardiovascular, and central nervous systems. Bone marrow damage causes pancytopenia, resulting in increased susceptibility to infections and clotting abnormalities. Progressive symptoms include lethargy, exhaustion, headaches, nausea, vomiting, diarrhoea, fever, haemorrhage, diminished vision, respiratory distress, mental impairment and secondary infections, climaxing in total collapse and death by respiratory or cardiac failure. (Mole, 2016). Apparent inconsistency in the severity and timing of effects is also recognised in modern studies, which note wide variations according to dose, latency, and individual sensitivity. (Seibold et al, 2020, pp. 324-399).

The indication of radiation poisoning is consistent with the legendary curse of the ancient mastaba tombs, which were *haram* (forbidden, prohibited) because of *illahat* (evil spirits) causing a disease no doctor could diagnose. The question remains as to the ultimate source of the unusual (unnatural?) levels of radiation previously reported.

Background Context

The orthodox view of the mastaba as a tomb reflects a humanised religious interpretation of ancient Osirian funerary rituals. From earliest times, the humanoid 'god' Osiris was known as the son of the Sun god (*Ra*) manifested on Earth to save mankind from darkness. Osiris 'died' but was resurrected. His dead body was ritually prepared, fed with cakes and ale, then placed within a stone chamber where it magically *transformed* into incandescent light and ascended into the sky to be reunited with God the Father in the heavens. The earliest Egyptians of the Old Kingdom believed this process was literally, physically true, accomplished by alchemy or magic, not understood by ordinary men. Contemporary Egyptologists have designated the pyramid as a "resurrection machine" (Edwards, 1961, p. 286) or "cosmic engine" (Lehner, 1997, p. 20), a structure or mechanism that enabled the *transformation* to take place.

Following the hiatus of the First Intermediate Period (ca. 150 years, 5-6 generations), ordinary Egyptians inherited the Old Kingdom funerary literature, which was reputed to hold great secrets. The ancient texts cautioned against revealing the mysteries - this book is secret, do not show it to common people, let no one see it. Common people are ignorant of this book. Do not show it to any other person. [It] is a true mystery which is known by no man anywhere (Faulkner 1969, Utt. 484; Faulkner, 1972, Sp. 161). The *Book of the Dead* also made a distinction between the prior kings of the Old Kingdom versus ordinary mankind who were characterised (in translation) as 'common folk' (Faulkner, 1972, Sp. 38B, 42, 65, 69, 161, 182); noting that the transformations of Osiris [into light] were not understood by mankind, because it was an exceedingly great mystery which no man knew. It was an abominable thing not to be disclosed to those who dwell in the swamps. (Budge, 1895, pp. 187, 217, 219; Budge, 1901, Chapt. CLXIII, p. 535). The magic of transformation was not just a secret but a terrible, dreadful thing not to be revealed.

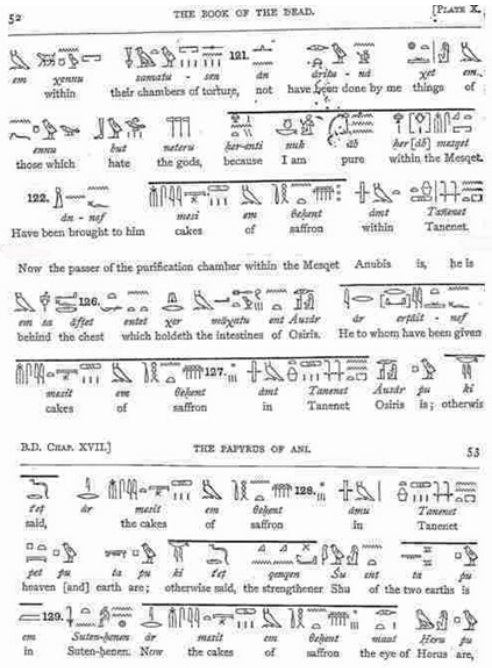
The old texts were overlaid with symbolic religious rituals and language in a childlike attempt to imitate the earlier gods, but there remains clear textual and physical evidence of the original literal content.

The outcome was vividly recounted in the funerary texts, albeit in personified language. Osiris came forth from the House of the Rising Sun (*akhet,* horizon), from the Island of Fire, where his body was filled with magic. Flame went up from the pyramid, causing fear and trembling in those who watched. He rose in the mountain (pyramid) with a double plume of rays of turquoise light to the height of heaven, flooding the world with light. The [two] apertures of the sky windows were opened, the sky reeled, the earth quaked (Faulkner, 1969, Utt. 477, 479, 482, 485, 503, 508-510, 536, 584, 604; Faulkner, 1973, Sp. 30, 283, 317,422, 573, 609, 650, 707, 753, 849).

The source of the power of *transformation* was the invisible 'efflux' from the magic offerings. Osiris declared (in the *Coffin Texts*) - I have power by means of offerings; I go forth by means of the efflux; by means of the magic; take the efflux so you shall not be inert; go forth from the burning fire; I have eaten the magic of the spirits of the magic food; the souls are in me, the shades are in me; I am transformed into mighty spirits; I shine in the sunshine, from the efflux. I am the primeval one; my soul possesses power in its primeval form. (Faulkner, 1973, Sp. 95, 101-2, 246-7, 317, 469, 573, 690, 705, 824, 829, 936, 895).

The magic food was detailed as *tchefau*, light food in the form of cakes and ale (or bread and milk). Cakes of saffron were brought to him [Osiris]; he was given saffron cakes in the coffer; the cakes of saffron are the eye of Horus. (Budge, 1895, Chapt. XVII, pp 52-53, Figure 1). Saffron (yellow) cake was further detailed in a series of Food Spells in the *Coffin Texts* where the efflux came from magic food of [unknown hieroglyph] in portions of 2-3-5; the movement of the sunshine was provided in meals of 2-3-5 portions (reversed in the hieroglyphs) (Faulkner, 1969, Utt. 205, 409; Faulkner, 1973, Sp. 191, 209, 211, 212, 217, 218, 587, 659, 667; Figure 2).

Yellowcake-235 is recognisable now as the crude ore of uranium-235 (U_{235}), the primary fuel of modern nuclear technology. Crude yellowcake is insufficient to cause a nuclear reaction and must be enriched to a higher concentration, which has the form of a chilled milky liquid. That process was also detailed in the *Coffin Texts* in recognizable terminology. The food [yellowcake] was made


52 THE BOOK OF THE DEAD. [PLATE X.

121. their chambers of torture, not have been done by me things of

those which hate the gods, because I am pure within the Mesqet.

122. Have been brought to him cakes of saffron within Tanenet.

Now the passer of the purification chamber within the Mesqet Anubis is, he is

126. behind the chest which holdeth the intestines of Osiris. He to whom have been given

127. cakes of saffron in Tanenet Osiris is; otherwis

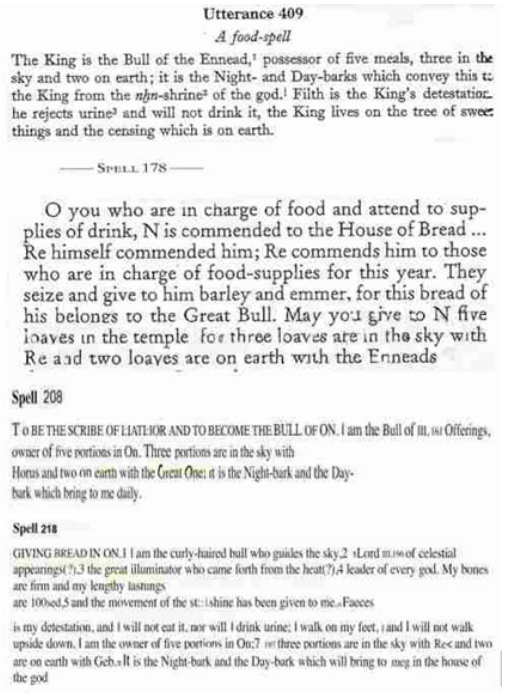
R.D. CHAP. XVII.] THE PAPYRUS OF ANI. 53

128. said, the cakes of saffron in Tanenet

heaven [and] earth are; otherwise said, the strengthener Shu of the two earths is

129. in Suten-henen. Now the cakes of saffron the eye of Horus are,

Figure 1. Saffron [yellow] Cake in the *Book of the Dead* (Budge, 1895).


Utterance 409

A food-spell

The King is the Bull of the Ennead,[1] possessor of five meals, three in the sky and two on earth; it is the Night- and Day-barks which convey this to the King from the *nḫn*-shrine[2] of the god.[3] Filth is the King's detestation, he rejects urine[3] and will not drink it, the King lives on the tree of sweet things and the censing which is on earth.

—— Spell 178 ——

O you who are in charge of food and attend to supplies of drink, N is commended to the House of Bread ... Re himself commended him; Re commends him to those who are in charge of food-supplies for this year. They seize and give to him barley and emmer, for this bread of his belongs to the Great Bull. May you give to N five loaves in the temple for three loaves are in the sky with Re and two loaves are on earth with the Enneads

Spell 208

To be the scribe of Hathor and to become the Bull of On. I am the Bull of [illegible] Offerings, owner of five portions in On. Three portions are in the sky with Horus and two on earth with the Great One; it is the Night-bark and the Day-bark which bring to me daily.

Spell 218

Giving bread in On.1 I am the curly-haired bull who guides the sky,2 Lord [illegible] of celestial appearings(?),3 the great illuminator who came forth from the heat(?),4 leader of every god. My bones are firm and my lengthy lastings are 100s,5 and the movement of the st[illegible]shine has been given to me.6 Faeces is my detestation, and I will not eat it, nor will I drink urine; I walk on my feet, and I will not walk upside down. I am the owner of five portions in On;7 [illegible] three portions are in the sky with Re and two are on earth with Geb.8 It is the Night-bark and the Day-bark which will bring to [illegible]meg in the house of the god

Figure 2. Text Examples of 'food supplies' Characterized in Portions of 2-3-5. (Faulkner, 1969,1972,1973).

pure, and the milk was restored to its proper level. Osiris declared - I am the son of the Milk Goddess. My mother gave censing of incense (efflux). I suckled my mother (for milk) of the rotting putrefaction (decay). He swallowed the spirits; he received pure offerings whose names and shapes were unknown. (Faulkner, 1973, Sp. 529, 467-8, 335, 306, 1017). Elsewhere the *Pyramid Texts* presented similar detail - Osiris received the milky fluid from the breasts of Isis; he received the efflux from the cold drink; the efflux of decay; the cold drink is yours, efflux is yours, the powers are in it. (Faulkner, 1969, Utt. 413, 470, 661, 423, 536, 553, 676, 679).

Physical evidence of intense fire may still be observed inside the Great Pyramid. The funerary text description of the Cooking Pot in the House of the Rising Sun (*akhet*) corresponds to the upper King's Chamber, where the double plumes of fire emerged through the two vent shafts, observed by early archaeologists to be scorched and blackened by fire that darted through them. (Vyse, 1840, II, p. 160, 201, 212) The intensity of the fire raised the roof beams, as noticed by Petrie, who recorded that the walls had expanded by an inch or two and roof beams were cracked and raised out of position by 3 inches (75 mm). (Petrie, 1883, p. 80, 93). The internal walls of the King's Chamber were initially misreported as polished marble because they reflected torchlight, but they are actually granite, which glistens because the surface is vitrified by extreme heat. The stone coffer is composed of ordinary grey granite, but its surface has an unnatural chocolate

brown colour, as if baked by extreme heat, and the edges show signs of melting (Dunn, 1998, pp. 211-212; Petrie, 1883, pp. 80, 93; Vyse, 1840, pp. 41, 83).

It follows that the expression of uranium-based technology would also develop radioactive waste products that would have to be managed by burial, for which there is also textual and physical evidence. In Egyptian legend, on the death of Osiris, the pieces of his body were enclosed in a lead-lined coffin and buried deep underwater. That scenario is consistent with the structure of the Osiris tomb at Giza adjacent to the pyramids, which consists of a 30 m deep vertical shaft filled with water, at the bottom of which was a dense dacite sarcophagus of ca. 30-40 tons. Basalt coffers at level 2 (ca 20m.) have been examined by the Geiger counter and found to be intensely radioactive, particularly on the inside (Temple, 2010, pp. 43-80, 297).

Finally, the *Book of the Dead* states directly that the dead body of Osiris is excrement [waste], which is everlasting. It cautioned mankind to get back (away) from the corpse, where the guardians of the tomb of Osiris held back the harmful spirits. Get far away from the shades of the dead - the *ka* (soul) - lest the slayers grasp you. Finally, the King says, in naïve personalized translation - I hate filth, I detest faeces, I reject urine (wastes), what I hate is buried in the cavern of the underworld [underground?], where those things cause fear and terror (Budge, 1895, pp. 31, 173, 336, 338; Faulkner, 1972, Sp. 92).

The waste excrements of dead Osiris contained harmful spirits that were everlasting and were buried in an underground bunker, in the *pr dj't,* house of millions of years.

Radiation Source

Unusually high radiation levels have been documented in Old Kingdom tomb ruins; in two locations at Giza and as radon in several underground tombs at Saqqara. Radon (Rn-222, Rn-220) is a radioactive gas emitted from decay of uranium, with a half-life of 3.8 days. The reports detected ambient radioactivity but did not identify the primary source.

Radiation has been detected by the Geiger counter at two sites at Giza adjacent to the pyramids. The readings were described as intensely radioactive in the magazines in the basement of Khafre's Valley building; while underground at level-2 of the Osiris tomb shaft, intense radioactivity was associated with two stone coffers, especially from the interiors. (Temple, 2010, pp. 43-80, 297). Temple described the coffers as granite, but Hawass (2007, pp. 379-397) classified them as basalt. The distinction is important because natural low-level radioactivity is recognised in coarse-grained granite, less so in fine-grained denser granite (diorite), and rare in basalt or limestone (Hurley, 2009, p. 14). Temple also noted that the coffers, particularly the interiors, were a point source of radiation, as opposed to general trace natural levels (of radon) from the surrounding limestone bedrock.

Other studies have directly measured radon gas at various locations in tombs at Saqqara. Radon gas is an intermediate product of uranium decay, with a half-life of 3.8 days. It is ubiquitous at low levels and is generally regarded as a natural product of traces of uranium in parent rock. Chen (2023, pp. 244-256) reported a worldwide study of 474 underground non-uranium mines, which found an average 'natural' level of radon of 574 Bq/m^3, a number inflated by extreme levels in phosphate deposits and in inactive unventilated mines. The WHO reference level for radon in indoor air is 100 Bq/m^3; the USEPA advisory level is 150 Bq/m^3; and the ICRP reference level is 300 Bq/m^3. Levels above 200 Bq/m^3 pose a significantly increased risk of lung cancer (Salama et al., 2018, pp. 950-956).

Studies in the ruins at Saqqara measured ambient radon concentrations at six locations: in the South Tomb, in the magazines of Djoser's pyramid, and in the Serapeum tomb tunnels. Measurements ranged from 1068-2866 Bq/m^3 in winter and 2394-4592 Bq/m^3 in summer, with the highest readings in the South Tomb (2866-4077 Bq/m^3) and position-3 in the Serapeum (2387-4592 Bq/m^3). (Salama et al., 2018, pp. 950-956). These levels were locally variable (within a site), an order of magnitude above maximum advised limits, and up to an order of magnitude above expected 'natural' background. The authors implicitly acknowledged the inconsistencies and proposed an explanation based on seasonal temperature and ventilation. They did not verify the natural level in the limestone, which is otherwise recorded as nil or rare (Hurley, 2009, p. 14), nor did they acknowledge that radon is a gas that might otherwise be expected to equilibrate within a closed tunnel system over an undisturbed measurement period.

Further studies at three locations in Old Kingdom ruins at Saqqara reported radon detections of 5809 Bq/m^3 (in the Sekhemkhet pyramid), 1202 Bq/m^3 (Abbis tunnels), and 816 Bq/m^3 (Serapeum tomb), an order-of-magnitude above maximum advised limits, and well above average 'natural' levels (Bigu et al., 2000, pp. 245-252). Those results were publicised under the heading "Pharaohs left behind a radioactive curse" (Edwards, 1999).

These measured levels of radiation are anomalous in magnitude and in localised distribution. Consideration of this unnatural profile of radiation prompts further examination of ancient Egyptian texts and archaeological

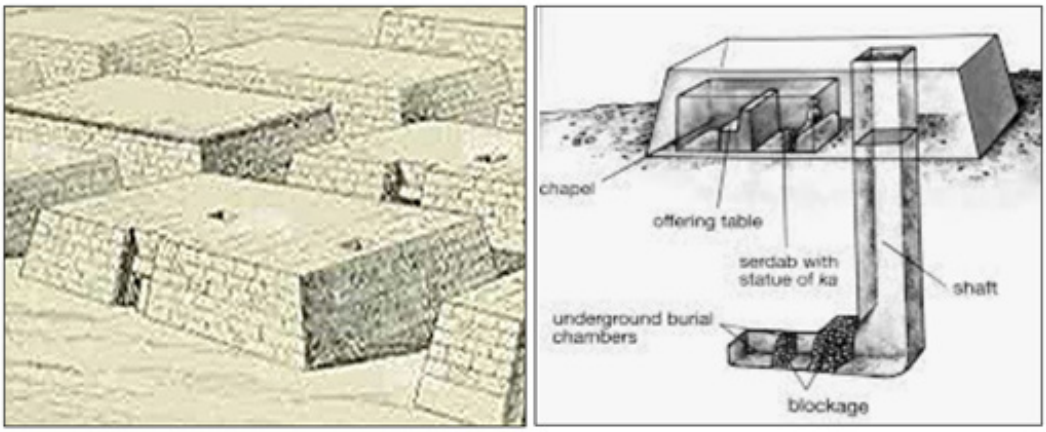


Figure 3. Typical Early Old Kingdom Mastaba, with Orthodox Labels (Wikipedia Commons).

records of the structure and operation of early mastaba tombs, revealing unexpected evidence that the original purpose of the *per D'jet* (secure house of millions of years) was consistent with long-term storage of nuclear waste of uranium-series decay products.

Mastaba Tomb Structure

The mastaba tomb of the Ancient Egyptian Old Kingdom began as a simple shallow pit, then evolved into a rectangular slab structure above ground, enclosing two small internal chambers and a 30 m deep vertical shaft extending to an underground burial chamber (Figure 3).

Key features of the typical early structure include:

- The 30 m deep shaft to the off-set burial chamber was deliberately loosely back-filled with rubble, with the upper section extended through the superstructure to an obvious external opening. The shaft and opening were not hidden and not secured in any way against later unauthorised entry.
- The first internal chamber enclosed a '*ka*' statue and had a series of small external openings at the top, like ventilation holes.
- The second chamber included a stone shelf, designated by early Egyptologists in religious terms as a chapel and altar for food offerings.
- Numbers of identical mastabas were set out in regular rows and columns (dubbed a cemetery by early Egyptologists) or arranged systematically around a larger central building (Figure 4, 5).

Figure 4. Regular Array of Mastabas in the 'royal cemetery' at Giza (4th dyn). (Reisner & Fisher, 1913).

It was clear to early archaeologists that these classic mastabas were of a single design and were arranged systematically in a unified construction project. They were not personalised according to the status or whim of a particular decedent. Similarly, the earliest mastabas were plain, undecorated stone or brick, without any trappings that might be expected of high status. It was only much later re-use, or later imitative copies, that introduced the confusion of intrusive burials and illustrative murals. And finally, the earliest mastabas explored by Petrie at Abydos and Reisner at Giza were lacking any trace of a mummy, body, or bones (Frankfort, 1961, p. 92; Petrie, 1900; Reisner, 1927; Reisner & Fisher, 1913). Not just missing as if later robbed, but forensically empty of any sign whatsoever of use as a human tomb. Even in the classic case at Giza, where Reisner discovered an intact sealed stone coffer, when it was winched open, it was found to be empty.

It is also notable that the early mastaba design remained unchanged over a long period. Current doctrine claims the single slab mastaba evolved into a multi-layer step-pyramid design and eventually into a true smooth-sided pyramid. But observation shows that the original classic structure persisted over about 750 years from the early dynasties at Abydos to the 4th dynasty at Giza to the 5th-6th dynasties at Saqqara. The mastaba appears as an ancillary building rather than developmental.

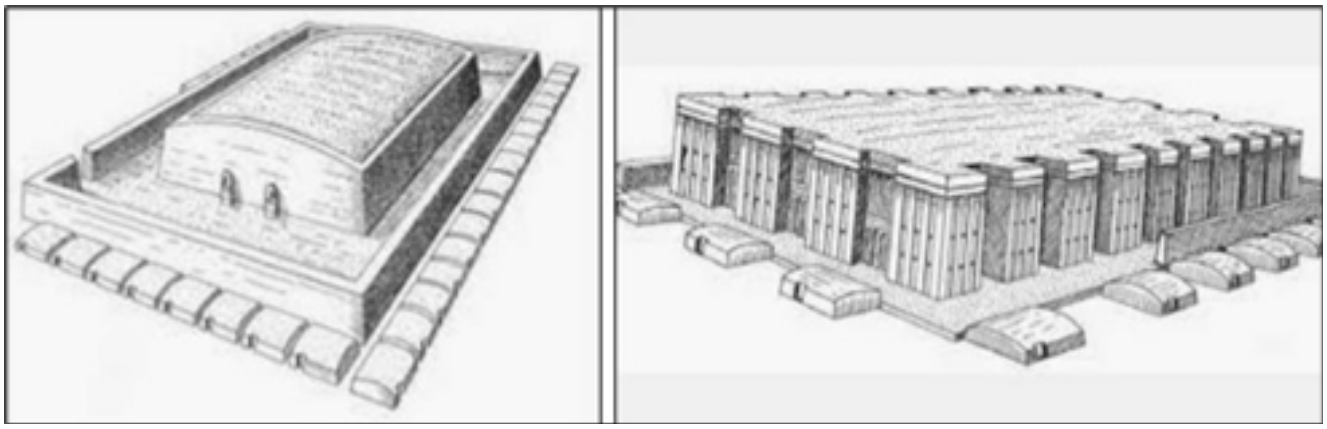


Figure 5. Systematic Arrangement of Mastabas. (Wikipedia Commons).

Mastaba Etymology

Mastaba is an Arabic term recorded by European Egyptologists in the early 1800s, where the local Arab workers referred to the collective ruins as *Haram el-Mastabat* (forbidden mastaba), which they declined to approach because of fear of *illahat* evil spirits.

Mastaba was interpreted by early Europeans as meaning 'bench' because it supposedly resembled a local domestic bench (seat) *when viewed from a distance.* But the mastaba structure is grossly oversized, disproportionately wide with impractical sloping sides, and encloses small rooms and a shaft, which are all quite inconsistent with a bench seat. Modern *mastaba* is from earlier Persian, which relates not to modern English bench, but rather to Old English *benc*, related to Latin *banc, banque*, or Celtic *bunke*, from which we get bank and bunk/bunker, meaning a vault for safe storage of something valuable or noxious. The association of *mastaba* with *benc* relates not to the above-ground shape but to the below-ground function. It was a vault or bunker.

Figure 6. Stacked Pots Suggesting Storage Rather Than Ceremonial 'offerings' (Emery, 1961; Jackson, 2014).

In Egyptian texts, the vault structures were called the *pr D'jt* (*per D'jet*), meaning the 'house of stability' or 'house of eternity' (literally millions of years), deriving from 1st dynasty King D'jet at Abydos, who was associated with planning/designing the underground basement. The *pr D'jt* was an underground chamber of stability (or security), also known as the 'house of the *ka*' (one of the aspects of the soul or spirit, together with the *ba*), located in an area called *t³-dsr,* meaning the 'secluded, cleared, isolated land', or the *crk-hh,* meaning 'securing for eternity' (Jackson, 2014).

A recent review of mastaba mural illustrations (from later periods) observed that the main activity portrayed was the carriage of offering pots to the mastaba *during the lifetime* of the King, as opposed to after death. The primary illustrated function was as a storehouse or depository for offerings (Zeinelabdein, 2018, pp. 180-195). It was an underground vault for stable storage of 'something' in pots for millions of years. The *t³-dsr* (isolated) zone became the Middle Kingdom religious sacred precinct, derived from sacrosanct (untouchable), which passed down to Arabic *haram* (forbidden).

Mastaba 'Offerings'

Physical evidence and illustrative murals indicate the original primary function of the mastaba was as an underground vault for permanent long-term storage of very large quantities of 'offerings' contained in stoneware pots. It is popularly perceived now that the offerings of beer or wine were intended to appease the gods and/or to sustain the deceased on his journey into the eternal afterlife. But those misperceptions were clouded by the later overlay of humanised religious rituals of Middle Kingdom priests, doubly reinforced by Euro-Christian Egyptologists who imposed a religious interpretation on the line

of bearers as a 'funerary procession' carrying oblations to be offered to the gods on an altar inside a chapel. In fact, the original offerings, in thousands of *stoneware* vessels, did not contain drink and were not offered ceremonially on the altar but stacked rather prosaically in the underground chambers (Figure 6).

Placement of vessels took place during the lifetime of the King; it was not associated with a funeral or interment of a body or mummy. The primary function actually illustrated was *storage,* not ceremonial oblations. It was a very large-scale systematic industrial process involving thousands of manufactured stoneware pots. Notably:

- There were literally thousands of pots. The tomb of 1st dynasty King Aha contained 200; tomb S3504 from the time of 1st dynasty King Dj't contained 4000; and Khasekhemwy's 2nd dynasty tomb contained 10,000. A total of 40,000 *stoneware* pots were later transported from 1st-2nd dynasty tombs at Abydos to be re-buried in the galleries deep beneath Djoser's Step pyramid at Saqqara (Fritschy, 2018, pp. 161-176).
- The pots were mainly made of dense stone, including basalt, diorite, and porphyry, mass-produced by unknown means to a very high standard with smooth surfaces inside and out (Takenouchi, 2021, pp.177-190).
- The pots were not positioned in a stylised ceremonial or ritualistic manner but rather were mundanely stacked for storage in underground chambers (Figure 6).
- The whole process was organised systematically, directed by a lector (instructor), recorded by an accountant or archivist, then guarded by a permanent *k3* priest, and subject to later checks by a travelling inspector (Zeinelabdein, 2018, pp. 179-198).
- The pots came from a central facility called the *pr-hd*, translated as the 'treasury' or 'house of stone' or 'house of the mace' (a weapon), responsible for producing the pots and/or the contents. (Fritschy, 2018, pp. 161-176).
- Most pots were uninscribed, but some were marked with a *phyle* name, designating the group or team who made or filled them (Takenouchi, 2021, pp. 177-190).
- Some pots at Abydos carried labels or tags made of bone (to last for eternity), marked with curious symbols, including a goose, a dove, and a snake (Dreyer & Kaiser, 1988).
- Many caches of stored pots were excavated very early, in the 1800s, and were speculated to contain unguent, beer, or wine (as later pottery vessels did). But the actual contents were a kind of oil, mud, plaster, mortar, or ash (Takenouchi, 2021, pp. 177-190).

These features paint a picture of large-scale industrial operations. In the 3rd dynasty, an early mastaba at Saqqara was extended into a multi-layer structure that is now known as Djoser's Step-pyramid, and thousands of pots were moved from Abydos into new permanent storage in the magazines deep under the Step-pyramid. It was not a ceremonial oblation; it was a massive industrial-scale undertaking termed the 'refreshment', meaning renewal or reinstatement. It was as if the Abydos site had deteriorated over the centuries and had to be replaced. Egyptologists have noted the enormous scale of construction and logistics. Djoser's pyramid covered 15 ha within a 10.5 m high wall defining the forbidden zone, with literally miles of tunnels deep in the underlying limestone, along with the transport of 40,000 pots from Abydos to Saqqara, a task which Egyptologists have interpreted as an exercise in royal pomp and ceremony. Yet the end result was a *sacred* exclusion zone from which men were barred by a 10.5 m wall and 40 m. wide outer moat.

Despite the usual interpretation of early Egyptologists that the offering pots 'must have' contained drink or food, the actual determination of the contents as mud, plaster, or mortar has defied orthodox explanation and remains to be seen.

Mastaba Symbols

The above background provides a new perspective to interpret otherwise enigmatic symbols of ancient Egypt, such as the pot tags (labels) found in early tombs at Abydos and the so-called offering scenes illustrated in later mastaba murals. The explanation of ancient symbols has been doubly confused. First by the humanised imagery of Middle Kingdom priests, where it is difficult to distinguish if they were simply ignorant or if they deliberately used cartoon characters to communicate complex concepts. Secondly, by the lapse of time, where mastaba murals of the Middle Kingdom (ca 2000 -1500 BCE) are already ca. 500 to 1500 years after the original events.

Modern physics distinguishes *two classes* of nuclear radioactivity. Particle radiation (alpha and beta) and electromagnetic waves (gamma). Alpha particles (helium-4 nuclei) are relatively large, slow, and weakly penetrating; beta particles (electrons) are very small, highly active, and mildly penetrating; and gamma rays (e-m waves) travel only in straight lines, are highly penetrating and very damaging to bone marrow causing haematopoietic cancers.

Correspondingly, the Ancient Egyptian scheme presented *two types of soul* or *spirit* that emerged from the 'dead body' of Osiris - the *ba* and the *ka* - designated as

Figure 7. The 'ba' Spirit Symbolised as a Bird (Wikipedia Commons).

aspects of the 'soul' in 19th-century quasi-religious language. Puzzlingly, the *ba* and *ka* left the body but didn't go away; they hovered around forever.

The *ba* was initially visualised as an abstract bird symbol, a flying object, or, in later, religious imagery with a human face (Figure 7).

Pot tags from Abydos (3400-3200 BCE) distinguished two kinds of birds, corresponding to the modern designation of alpha and beta particle radiation (Figure 8).

Alpha radiation (large, slow He-4 nuclei) was represented as a large, slow-moving goose.

Beta radiation (small active electrons) was represented as a small active bird (identified as a turtledove or a sparrow, often illustrated escaping up the vertical shaft of the mastaba. The common sparrow was the archetypical 'bad bird' representing harm and evil. (Bailleul-Lesuer, 2016, p. 10; hieroglyph G37, Gardiner, 1927).

The *ka* was believed to be potent and dangerous and was initially visualised as an abstract snake-headed symbol, only later humanised into upright human arms and hands. The snake subtly captured the sinuous motion of e-m waves, set at right angles to indicate straight line movement, and with the snake head representing the venomous bite causing fatal blood poisoning. Elsewhere, the 'snake-bite' symbol was also recognised as the insidious hazard of solar radiation. The ability of *'ka'* waves to penetrate stone was captured in hieroglyphs as the sign for a shrine or naos, a stone box containing the gods, but from which the *ka* 'snake' could still escape, illustrated in a mastaba mural (Figure 9,10).

The child-like imagery of radiation features as the

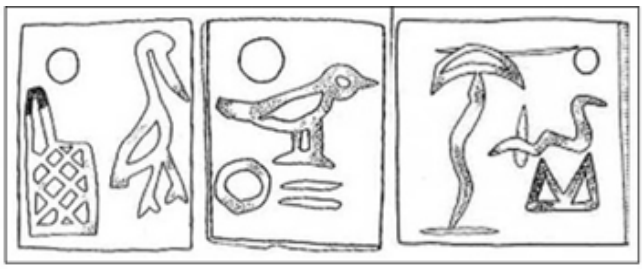


Figure 8. Pot Tags from Early Burial Vaults at Abydos – Goose, Sparrow, and Snake (Dreyer & Kaiser, 1998).

Figure 9. Fatal Gamma Waves Illustrated as the Venomous 'ka' Snake (Wikipedia Commons).

snake (waves) and birds (flying entities) was reinforced elsewhere in the *Pyramid Texts*, which described how the glory (radiance) of the light was inhuman (unnatural), appearing like the sun with spirits of "water and sand" (Faulkner, 1969, Utt. 565). That apparently fatuous expression may be interpreted in context as naïve imagery for 'waves' and 'small particles', e-m gamma waves, and small alpha and beta particles. The childish innocence of this imagery suggests an intellectual gap between the original authors in the Old Kingdom versus the 'common men' who were copyists and priests in the Middle Kingdom, perhaps 500-1000 years later.

Long-life radioactive wastes are ranked today by activity x quantity x longevity, and on that basis, two of the most troublesome isotopes are technetium (Tc-99) and caesium (Cs-135) with half-lives of 211,000 and 2.3 mil-

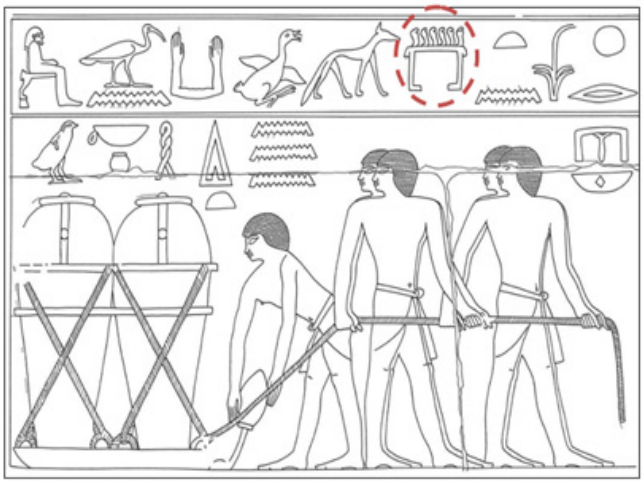


Figure 10. Mastaba Mural Illustrating Storage of Pots Containing 'ka'(snakes) and 'ba' (birds) (Linacre College, 2006).

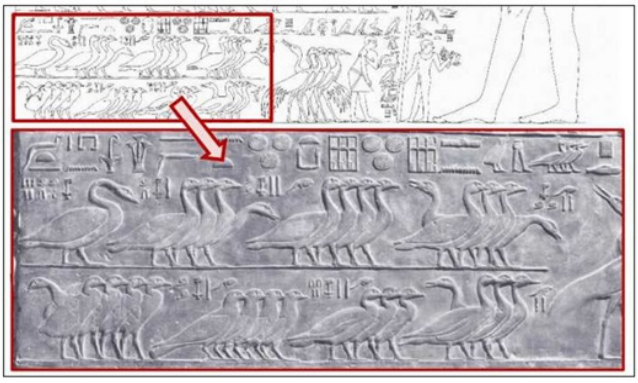


Figure 11. Mastaba Mural Illustrating Exact Large Numbers of Birds ('ba' spirits) (Bailleul-Lesuer, 2016).

lion years, respectively. Correspondingly, mastaba murals illustrate offerings of curiously exact, very large numbers of specific birds. The numbers vary in expression, suggesting they may have been corrupted by copying from some prior source. There are examples of 111,200 doves, 11,110 'birds', and 120,000 or 121,200 ducks or geese. (Bailleul-Lesuer, 2016, p. 613; Zeinelabdein, 2018, p. 190). These large numbers of specific birds suggest a code indicating the expected lifetime of the offering wastes stored in the *pr dj't* house (Figure 11):

- 111,200 doves x lifespan <2 years = ca. < 222,400 years = ca. half-life of Tc-99

- 120,000-121,200 geese x lifespan <20 years = ca. 2.4 M years = ca. half-life of Cs-135

Mastaba Mechanics

Why was the mastaba built in a systematic configuration, and how did it operate? The storage process was formally managed by a lector (instructor), an accountant/archivist, a *K3* priest permanent monitor/caretaker, and a travelling inspector. (Zeinelabdein, 2018, pp. 193-194). The background of nuclear waste storage for millions of years allows interpretation of the structure and operations, as follows (Figure 12):

- The burial chamber was 30 m deep in bedrock as a physical barrier to limit the escape of radiation, particularly gamma rays.
- The offerings (wastes) were contained in very hard, dense stone vessels (later coffers) to contain penetrating radiation.
- The contents of the offering pots were semi-solid mud, mortar, or plaster, consistent with a strategy to physically immobilise the radiation source rather than allow the development of hot spots or leakage of liquids.

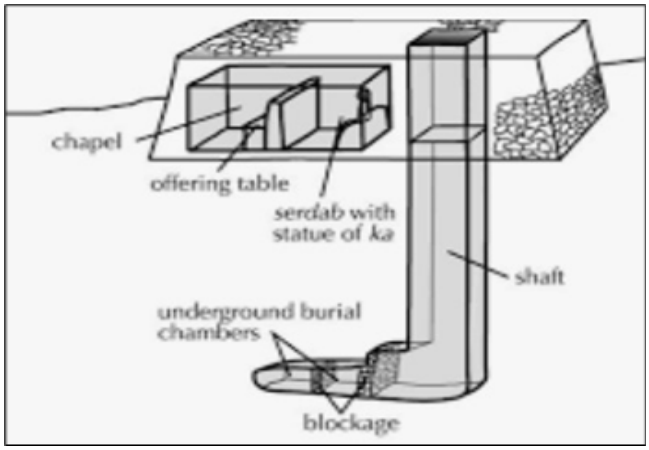


Figure 12. Typical Mastaba Structure, with Orthodox Labels (Wikipedia Commons).

- The burial chamber was offset from the shaft to limit the escape of gamma rays (*ka*), which only travel in straight lines.
- Mastaba murals showed some smaller *ba* birds (beta particle radiation) escaping up the vertical shaft. (West, 2019, p. 3).
- The shaft was deliberately loosely backfilled with broken rubble for two possible reasons: (a) for aeration to prevent overheating, or (b) to allow the subterranean chamber to be periodically filled with water as a moderator. There is no direct evidence of that, but it is consistent with the Osiris tomb and other textual references and with modern practice.
- In the above-ground cap, the inner chamber was located directly above the underground burial chamber, the shortest distance at which to detect possible leakage of gamma rays (*ka*). This chamber contained a *ka* symbol, indicating it was 'for the *ka*'. The chamber was ventilated by small holes at the top and was used to contain live bird(s) that acted as 'mine canaries' to detect possible leakage of *ka* (gamma radiation). Numerous texts refer to the ongoing delivery of live birds to the mastaba, probably the sacred ibis. Hebrew historian Josephus recorded that ancient Egyptians used caged ibes to detect evil 'snakes'. Birds, in general, are known to be acutely sensitive to radiation.
- The second (outer) chamber contained an 'altar' (shelf) used to present food offerings, which was a second strategy to detect sterilizing irradiation. If the food did not decay normally, that indicated the presence of sterilizing gamma radiation.

But before this level of ordered structure and management, the early 1st-2nd dynasty tombs at Abydos were more basic. Some were only relatively shallow pits with little or no covering superstructure or superstructure that deteriorated over time. A series of circumstanc-

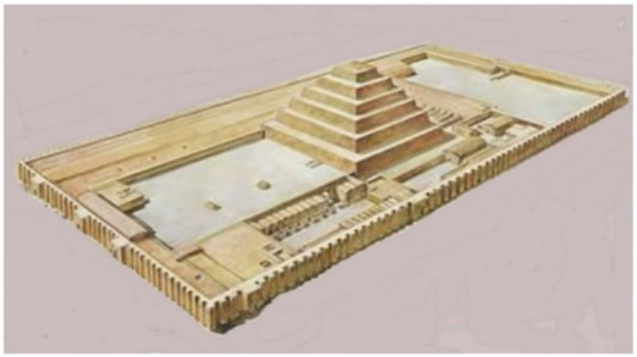


Figure 13. The Step Pyramid Complex (Wikipedia Commons).

es is consistent with radioactive leakage from these early tombs at Abydos:

- The Egyptian funerary texts state directly that Abydos was the site of the refining/enriching of the magic efflux - I have come that I may establish offerings in Abydos; pure is the efflux which was drawn from you; may you be mighty [stronger] in Abydos. (Faulkner, 1972, Sp. 117-119).
- According to Mantheo's History of Egypt, at the time of the 1st dynasty, under King D'jet, a very severe 'plague' affected that land.
- Hundreds of secondary non-elite graves at Abydos contained young men of 20-25 (and some women and dwarfs) apparently in good physical condition, uninjured, but speculated to have been poisoned (Recht, 2020, pp. 168-180). A similar scenario was reported at Kerma (Barta, 2011, pp. 63-65), where there were 30,000 graves in a small industrial town suggested elsewhere as a site of yellowcake U-235 mining/processing.
- Other studies of non-elite skeletons from the Old Kingdom have shown a significant incidence of degenerative joint disorders of the spine and cranial porosity, attributed to famine (or plague) but also known to be directly caused by radiation exposure. (Mant, 2014, p. 27)
- Around 2650 BCE, about 40,000 pots were disinterred from Abydos and transported downriver to be reburied deep underneath a massive new multi-layer mastaba (Step pyramid) at Saqqara. (Fritschy, 2018, pp. 161-176).
- The remaining empty tomb structures were deliberately purged by fire, consistent with a strategy for decontamination. (Emery, 1961, p. 97; Petrie, 1904; Richards, 2002).

The relocation event was called the 'refreshment of the gods' in 19th-century anthropomorphic language, better interpreted as remediation or literally reburial.

D'joser's Step Pyramid

The early tombs (burial vaults) at Abydos extended over a period of 4-500 years, from the late-predynastic through the 1st and 2nd dynasties, after which it must have become apparent that the initial design of shallow pits was allowing hazardous leakage of radioactivity causing 'plague'. Around 2650 BCE, King Djoser is credited with the massive clean-up of Abydos, removing ca 40,000 storage pots and reburying them under an expanded step pyramid 500 km downstream at Saqqara.

The step pyramid began with the classic design of a 30m deep vertical shaft, capped with an above-ground slab, square-shaped to accommodate the wide dimensions of the shaft and burial chamber below. That basic design was then extended in two further stages by widening and raising the superstructure to a total of six tiers, forming the now familiar Step Pyramid. The widened and raised superstructure served to shield a huge network of lateral magazines tunnelled into the bedrock below at the level of the original burial chamber (ca 30m). Into that deep subterranean complex, they re-interred about 40,000 pots of waste from the 1st to 2nd dynasty tombs at Abydos.

The final outcome was a Step Pyramid of 62 m. high

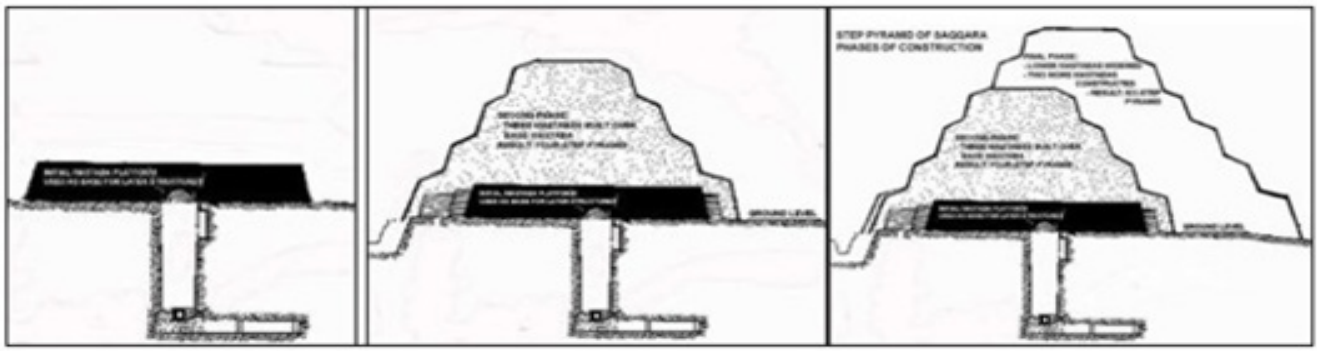


Figure 14. The Step-Pyramid Construction Phases (Wikipedia Commons).

with a base covering about 15 ha., within an impenetrable 10.5 m. high stone wall forming an enclosure 750 x 600 m. (45 ha.), In turn, it is surrounded by a monumental trench (moat?) 40 m. wide. It was a 'sacred' area - forbidden, *haram* -because of *illahat* evil spirits (Figure 13).

Djoser was commemorated later in Egyptian history on the so-called *Famine Stele*, which records that he saved the country from famine (plague?) by rebuilding the temple of Khnum. The whole exercise and resulting complex was translated as the *Refreshment of the Gods*, probably better interpreted as 'repair of the spirits' (Barta, 2023). It was a clean-up operation.

- The Step pyramid went through three to four stages of construction, illustrated below (Figures 14-16):
- The superstructure tiers were raised and widened to shield the lateral dimensions of the added underground storage galleries shown below:
- The initial design was an open-topped vertical shaft (ca 30m.) with a burial vault capped by massive granite beams and a 3.5-ton plug only 1 m. in diameter, later extended to include the extensive subterranean storage galleries discovered by French Egyptologist J. P. Lauer and reported by Quibell and Firth, (1935). About 40,000 storage pots were excavated and dispersed to museums worldwide.

As an aside, the pots were recorded to originally contain a kind of oil, mud, plaster, mortar, or ash (Takenouchi, 2021, pp. 177-190). At a nominal capacity of three to five liters each, the total quantity of contained material could have been in the order of 150-200 tons, which is unaccounted for.

Curiously, Lauer was unscathed and lived to the age of 99, but others at Saqqara were not so fortunate. J. Quibell died unexpectedly at 67 when still working, while his wife and co-worker (illustrator), A. Quibell, died at 65 of

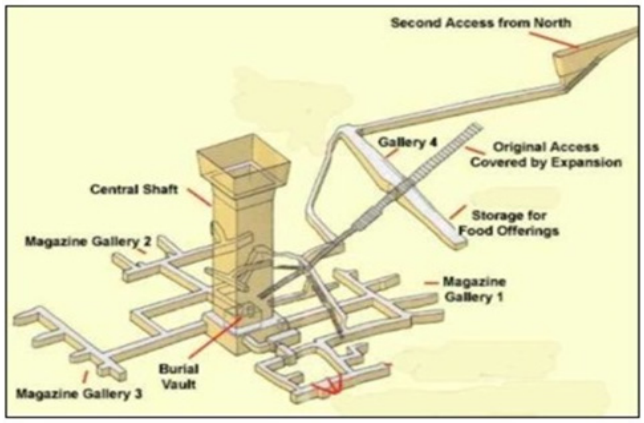


Figure 15. The Step-Pyramid Stage-4 Underground Structure (Wikipedia Commons).

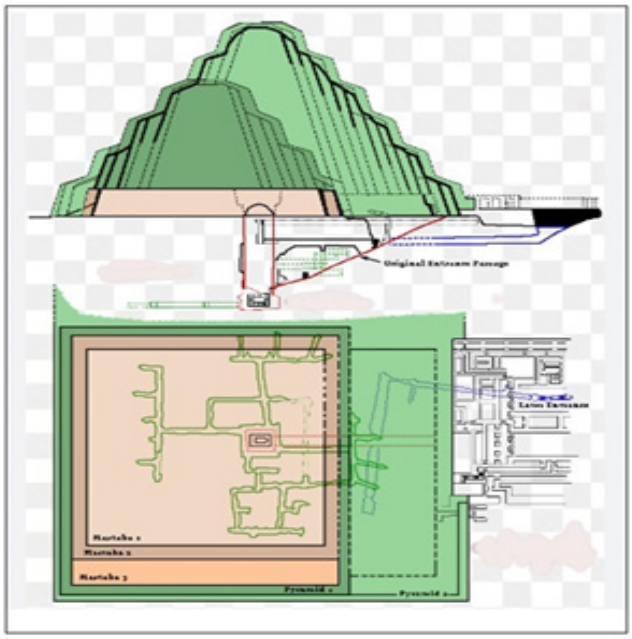


Figure 16. Final Footprint of the Step-Pyramid (pngwing.com).

leukemia. Pioneering Frenchman Mariette died at 59 of 'horrible haemorrhage', and his successor, Maspero, retired for ill health and collapsed and died of a nominal heart attack at 70. Champollion led a study of the texts inside the pyramids, after which six team members died early, unusual deaths (detailed earlier).

DISCUSSION

This paper makes a series of observations of the strong radiation in ancient Egyptian mastaba tombs, the associated unusual deaths of Egyptologists, and possible sources of the unusual/unnatural radiation:

- Prior literature has recorded hazardous levels of radiation [as radon] in tombs of up to 4-5000 Bq/m^3 versus advisory 'safe' limits of 100-300 Bq/m^3. Radon is a radioactive gas released from uranium decay, with a half-life of 3.8 days.
- Data from modern-era field Egyptologists and associates exposed to the excavation of tombs reveals high rates of death to cancer, nominal cardio-vascular failure, and other typical symptoms of haematopoietic cancer, corresponding to what is now recognised as radiation sickness. The rates of cancer and nominal heart failure alone are 3-4%, more than 10X the expected level for western Europeans.
- Prior publications reported highly unusual radiation (as radon) in underground tombs, up to an order of magnitude above expected levels, which was attributed to natural sources. However, the actual level of

background substrate radiation was not verified, and the extremely high, localised rates are not consistent with the accepted natural background (low in fine granite, nil, or rare in basalt and limestone). Radon gas is an intermediate product of uranium decay with a half-life of 3.8 days - high levels imply an adjacent source of uranium series decay.

- The possibility of abnormal, unnatural radiation raises consideration of alternative sources. Examination here reveals unexpected textual and physical evidence of uranium-based technology in ancient Egyptian funerary literature and in archaeological records of mastaba tombs.
- Egyptian funerary literature (*Pyramid Texts, Coffin Texts, Book of the Dead*) is known from about 2300-2100 BCE onward but recognised as derivative from some earlier source. It is viewed as a largely unintelligible, mystical guide to the afterlife. Here, a re-examination of standard translations reveals frequent, plain language descriptions of nuclear technology. Osiris was 'transformed into light', described presciently as a primeval substance, unformed matter, first born son of matter, light at its birth, formed of atoms. He had power and transformed by means of invisible emanations of 'efflux' from saffron cakes of 2-3-5 (yellowcake U-235) ... a 'magic power' which early translators rendered as a foul flux, efflux, incense, censing, unguent, perfume, essence, spirits or fumigation. That terminology was rendered unwittingly in several English translations in the late 1800s when modern-era nuclear technology and language were still unknown.
- Archaeological records of mastaba tombs reveal structural and functional characteristics that are consistent with an original purpose for secure, long-term underground storage for nuclear waste. Texts record that the hated excrements of Osiris, the wastes that follow causing death, were buried in the underworld cavern [bunker]. That corresponds to the isolated, forbidden *per D'jet* underground vault of millions of years, storing stone pots labelled with the goose, the evil sparrow, and the venomous snake ... symbolizing alpha, beta, and gamma radiation. The thousands of pots excavated under the Step Pyramid in the 1960s contained potentially 150-200 tons of unidentified substances that are unaccounted for.
- Funerary literature also alludes to possible sources and processing of nuclear fuel. Texts make several references to *tchefau* food of the shining ones produced by digging the earth at *Sekhet Aaru* for a food offering that comes from southern Egypt. The 'magic food' was processed by diffusion in a 'wine press' or 'purification tent' or by a 'whirling dust devil' (centrifuge). The efflux was made pure and stronger at Abydos; the milk was restored to its proper level in the regeneration place at Abydos. It entered the dust devil, and it emerged pure (*Coffin Texts*, Sp 471, 526, 594). Those allusions to processing are not pursued further here.

Prior published accounts confirm hazardous levels of radiation in ancient Egyptian tombs, which is shown to be linked to a pattern of radiation sickness in modern-era Egyptologists. However, the underlying source was not verified. Here, a sequence of characteristics suggests unnatural radiation in the mastaba tombs is consistent with the storage of nuclear waste; an unorthodox observation but with sufficient evidence to warrant more detailed comparative measurements, including analysis of the surrounding substrates.

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APPENDIX

	BIRTH/ DEATH	AGE OF DEMISE	CASUE OF DEMISE	NOTES
CANCER				
Adams, B	1945-2002	57	Cancer	Excav at Hierakonpolis and Abydos; curator Petrie Mus at UCL. Suddenly of cancer
Edwards, A	1831-1892	61	Cancer	Many years in Egypt. Founded Egypt Exploration Soc.
Fattovich, R	1845-1918	73	Cancer	Excav widely in Egypt & Ethiopia.
Goedicke, H	1927-2015	88	Cancer	Excav at Abu Simel and at Giza. Academic at John Hopkins. Of cancer
Grdseloff, B	1915-1950	35	Cancer	Worked with DAI in Cairo (and Abydos?)
Hart, G	1945-2021	75	Cancer	Studied at UCL, lifetime lecturer at Brit Museum
Hayter, A	1863-1927	64	Cancer	Excav with Petrie at Hawass, Quibell at Saqqara
Hecker, H	1935-2002	67	Cancer	Excav at Memphis, Giza and Amarna.
Hoffman, M	1944-1990	46	Cancer	Excav at Hierakonpolis.
Keller, C	1945-2008	63	Cancer	Curator various museums. Studied murals at Thebes. Pancreatic cancer
Lepius, K	1810-1884	74	Cancer	Fell ill suddenly after excavating at Valley of the Kings. Died of bowel cancer
Napoleon B	1769-1821	51	Cancer	Overnight in Grt Pyr. Devel nausea, abdominal pain, blood clots, gastric ulcers; stomach cancer
Spiegelberg	1870-1930	60	Cancer	Academic, philologist, collector in Egypt 1895-99. Died unexpectedly of bladder cancer
Weigall, A	1880-1934	54	Cancer	Excav with Petrie at Abydos, later widely at Thebes. Died prematurely of cancer
Carter, H	1874-1939	65	Hodgkin's	Explorer and collector, famous for discovering Tut's tomb. Hodgkin's lymphoma
Quibell, A	1862-1927	65	Leukemia	Asst Petrie at Thebes and Saqqara, later illustrator with J Quibell at Saqqara
Ritner, R	1953-2021	68	Leukemia	Career examining 'magic' Egyptian artifacts.
HEART/ STROKE				
Abel, H	1883-1927	44	Heart att	Early excav of Khafre pyr at Giza.
Baer, K	1930-1987	56	Heart att	Excav with Fakhry at Giza and Saqqara. Later Prof at Chicago
Benson, M	1865-1916	51	Heart att	Excavated tombs at Thebes. Suffered ill health, died of heart failure
Champollion	1790-1832	41	Apoplexy	Noted for translation of hieroglyphs. With Rosellini, studied Pyr Txts at Saqqara
Chester, G	1830-1892	62	Heart att	Collected 'unofficially' for Brit Mus, Bodleian & Ashmolean
Demel, H	1886-1951	65	Heart att	Excav necropolis at Giza, member of DAI. Curator Vienna Mus
Emery, W	1903-1971	68	Stroke ?	Excavated many tombs, incl Abydos & Saqqara. Collapsed in pyramid, died in 2 days
Fakhry, A	1905-1973	72	Heart att	Excavated at Siwa and Dashur. Died suddenly while travelling
Glanville, S	1900-1956	56	Heart att	British academic
Griffith, F L	1862-1934	72	Heart att	Philologist. Trained under Petrie and Naville in Egypt. Excav in Nubia and Amarna
Hogarth, D	1862-1927	65	Heart att	Excav in Mid East and Egypt. Curator at Ashmolean Mus. Sudden heart attack
Lucas, A	1867-1945	78	Heart att	Worked on excavation of Tut's tomb, examined artifacts. Died suddenly visiting Luxor
Lythgoe, A	1868-1934	65	Stroke?	Excav. with Reisner; at opening of Tut's tomb. Suff 'mysterious illness', cerebral arteriosclerosis ?
Makrahmallah	1903-1949	46	Heart att	Asst Dir at Saqqara 1931-37; later at Luxor. Died of heart ailment
Mallackh, el K	1918-1987	69	Heart att	Excav at Giza; discovered Khufu's boat
Maspero, G	1846-1916	70	Heart?	Pioneering excavations at Saqqara. Retired for health, died suddenly at an academic lecture
Perring, J S	1813-1869	56	Apoplexy	Worked with Vyse at Giza, later at Saqqara and Abusir.
Petrie, Hilda	1871-1957	86	Stroke	With Wm Petrie at Giza and widely elsewhere, esp as copyist and illustrator
Vandekerckhove	1959-1989	30	Heart att	Participated in excav at El Kab, 1981-87
'ILL HEALTH'				
Aksamit, J	1958-2008	50	Illness	Excav at Dier el Bahari. Suff same 'illness' as colleague Lipinska
Alpini, P	1553-1616	63	Kidney infection	Explored inside the Great Pyr at Giza.

Ballerini, F	1877-1910	33	Fell ill	With Schiaparelli at Thebes, Giza, Heliopolis & Dier el Medina. Suddenly fell ill
Bates, O	1883-1918	35	Illness	Excav in Nubia 1908-10. Took ill and died in army camp
Belzoni, G	1793-1823	45	Dysentery?	Early tomb explorer and collector of artifacts. Died suddenly, attrib to dysentery
Bethell, R	1883-1929	46	Asphyxia	Asst excav of Tut's tomb. Collector of small antiquities. Susp 'suffocation' in Ldn club
Bidoli, D	1934-1973	39	Illness	With various German excavations. Died of 'an illness'
Bilharz, T	1825-1862	37	Asthma/ typhus?	Noted discoverer of bilharzia. Also explored tombs. Sudden death to asthma or typhus?
Blackman, A	1883-1956	73	Fever	Excav with Reisner in Nubia. Suffered typhoid fever
Bouriant, U	1849-1903	54	Ill health	Assoc of Maspero, excavated at Thebes. Dir IFAO until health failed
Breasted, J	1865-1935	70	Strep / malaria	Many years in Egypt, at opening of Tut's tomb. Died of strep infection or malaria
Burton, H	1879-1940	60	Diabetes	10 yrs photographer at excavation of Tut's tomb; health declined from 1937
Callender, J	1940-1987	47	Ill health	1986 took position with Amer Uni Cairo, but resigned due to ill health
Carnarvon	1867-1923	56	Blood poisoning	Died soon after opening Tut's tomb. Erysipelas and strep blood poisoning
Currelly, T	1876-1957	81	Illness	With Petrie in Egypt. Avid collector, curator at Toronto Mus. Fell ill, died in hospital
Denon, V	1747-1825	78	Pneumonia?	With Napoleon in Egypt. Ist curator at Louvre. Caught cold and died in 2 days
Deveria, T	1831-1871	40	Ill health	Excav with Mariette, asst curator at Louvre; suffered ill health
Drovetti, B	1776-1852	76	Insanity?	Prolific [illicit] collector in Egypt, incl. Turin King List. Died in lunatic asylum
Ebers, G	1837-1898	61	Ill health	Collected at Thebes, noted for Ebers Papyrus. Later academic. Retired for ill health
Firth, C	1878-1931	53	Pneumonia	Excavated widely with Petrie and later at Saqqara. Died on holiday, of pneumonia
Firth, W	1872-1937	75	Illness	Copyist for Petrie at Giza, Abydos, Saqqara. Died after long illness
Frediani, D	1783-1823	40	Insanity?	Associate of Belzoni and Drovetti [collectors]. Died insane
Gould, J G	1864-1923	59	Pneumonia	Present at opening of Tut's tomb, contracted fever and died of pneumonia
Grenfell, B	1869-1926	57	Ill health	Excav with Petrie, later explored widely for papyrii. Suffered ill health
Hall, H	1873-1930	57	Pneumonia	Asst curator at Brit Mus; excav for EES at Abydos. Caught cold and died
Jonckheere	1903-1956	53	Prematurely	Made study of mummies in Egypt 1939-42
Lansing, G	1825-1892	67	Ill health	Lived in Egypt from 1856; collected papyrii. Ill health from 1886
Legrain, G	1865-1917	52	Pneumonia	Asst de Morgan at Karnak & Luxor. Illustd many sites. Sudden illness, died in few days
Leider, R	1798-1865	67	Cholera	Missionary in Egypt 1825-62; collected antiqs
Lenormant	1802-1859	57	Fever	With Franco-Tuscan Expedition 1928-29. Died of fever while travelling
L'Hote, N	1804-1842	38	Frail health	With Champollion's study at Saqqara 1928-29, and elsewhere
Lipinska, J	1932-2009	77	Illness	Excav widely [at late sites?]. Died of unspecified 'illness'
Mace, A C	1874-1928	53	Poison/pneu	Worked with Petrie and Reisner, and at Tut's tomb. Retired for ill health
MacKay, H	1880-1943	63	Nat causes'	Excavated with Petrie at Thebes 1907-1912. Died of natural causes
Mariette, A	1821-1881	59	Haemorrhage	Pioneering excav at Saqqara. Died in Cairo of haemorrhage / possible diabetes
Misset, E	1775-1820	45	Ill health	Brit Consul 1803-16, resigned for ill health. Assoc of Athanasi
Moller, G	1876-1921	45	Malaria	Excav at Abusir and Dier el Medina, 1902-12. Died suddenly, susp malaria
Najib, A	1847-1910	63	Ill health	With EAS but retired for ill health
O'Connor, D	1938-2022	84	Parkinson's	Excavated for long period at Abydos. Died of Parkinson's
Osman E	1791-1835	44	Dysentery	Resident Egypt, asst Salt, Burchardt, Hay
Pendlebury	1904-1941	37	Haemorrhage	Excav at Amarna. Possibly shot?
Perry, W J	1887-1949	62	Parkinson's	At UCL 1923-39, retired early due to Parkinson's
Petrie, Wm	1853-1942	89	Malaria?	Long career of excavation, esp Abydos and Giza. Died in hospital in Jerusalem
Reid, A D	1871-1924	53	Radiation?	Radiographer, X-rayed Tut's mummy. Already in ill health, died in 3 Days
Reisner, G	1867-1942	75	Poisoning?	Excav mastabas at Giza. Collapsed inside the Grt Pyr, died later of 'poisoning'?
Rhind, A	1833-1863	29	Pulmonary dis.	Excav and collected at Luxor and Giza. Died of pulmonary disease
Ricci, A	1795-1834	39	Poison?	5yrs in Egypt exploring, illustrating, collecting. With Champollion 1928-29
Rosellini, I	1800-1843	43	Malaria?	Assoc of Belzoni. With Champollion at Saqqara. Death attrib to malaria

Seetzen, U	1767-1811	44	Mysterious	Explored Giza, Saqqara, Heliopolis. Large collection. Died mysteriously
Settgast, J	1932-2004	72	Ill health	Excav briefly at Thebes 1966. Retired 1985 for ill health
Sicard, C	1677-1726	49	Plague	Missionary in Cairo. Explored widely
Smolenski, T	1884-1909	25	Premature	Studied with Maspero. Several excavations of tombs. Died prematurely
Weidenbach	1818-1882	64	Ill health	Artist with Lepius excavations. Retired for ill health
Wilkinson, J	1797-1875	78	Ill health	Explored 1821-33, suffered 'ill health'; again in 1855-56 suffered 'sunstroke'
Winlock, H	1884-1950	65	Ill health	Excav widely 1906-31; Dir of Met Mus of Art.; extensive 'finds'; suffered ill health

'SUDDEN'

Akerbald, J D	1763-1819	56	Sudden	Early translator of demotic script. Collected antiquities. Died suddenly in Rome
Anderson, H	1799-1875	76	Sudden	Collected mummies and antiqs, now in Brooklyn Mus. Sudden illness in Lahore
Anderson, R	1927-2015	88	Sudden	Excav at Saqqara and Nubia. Died suddenly after short illness
Andrzejewski	1923-1961	38	Sudden	Excav widely in the Delta with Polish Arch Inst. Died unexpectedly when still working
Borchardt, L	1863-1938	74	Sudden	Excavated widely in Egypt, discovered bust of Nefertiti. Died suddenly while travelling
Branicki, A	1821-1877	56	Sudden	Collected antiquities from private expeditions. Died suddenly in Nice
Brunton, G	1878-1948	70	Unexpected	Excav with Petrie. Later curator at Cairo Mus
Cerny, J	1898-1970	72	Unexpected	Excav at Dier el Medina 1925-70. Unexpectedly within few days of return from Egypt
De Buck, A	1892-1959	67	Unexpected	Prof at Leiden. Noted translator Coffin Texts. 5 years in Egypt. Died unexpectedly
Derry, D E	1874-1961	86	Sudden	Early curator at UCL. Later Prof Egyptian Mus, Cairo. Examined mummies
Donati, V	1717-1762	45	Unexpected	Collected antiquities for Turin Mus; died unexpectedly on ship to India
Dreyer, G	1943-2019	76	Unexpected	Extensive excavations at Abydos
Engelbach, R	1888-1946	57	Sudden	Longtime curator at Cairo Mus. Asstd Petrie and Carter. Suddenly in Cairo hospital
Garstang, J	1876-1956	80	Sudden	Excavated with Petrie at Abydos. Died suddenly on holiday
Hussein, R A	1971-2022	50	Sudden	Worked for 7 years at Giza and Saqqara. Died of sudden severe illness
Jones, H	1877-1911	34	Sudden	Excav & illustrator. With Garstang at Hierakonpolis & Abydos. Suddenly at Thebes
Kaiser, W	1926-2013	87	Unexpected	Extensive excavations at Abydos. Died unexpectedly
Krall, J	1857-1905	48	Unexpected	Coptic scholar. Died 'unexpectedly'
Peet, E	1882-1934	52	Sudden	Excav at Abydos with Naville, and independently. Died suddenly
Quibell, J E	1867-1935	67	Unexpected	Identified & excav pre-dyn sites. Notable for Narmer palette. Died when still working
Ransom Wm	1872-1952	79	Sudden	Excav at Luxor; Cairo Mus; asst curator at the Met. Sudden illness, died in 1 week
Segato, G	1792-1836	44	Sudden	Studied tombs and mummies at Saqqara. Died suddenly, prematurely
Sibeud, J	1814-1877	63	Sudden	In Egypt 1841-42, collected antiqs
Tassie, G	1960-2019	59	Sudden	Explored in Egypt; curator at UCL & Cairo Mus. Suddenly took ill and died in Cairo
Tefnin, R	1945-2006	61	Unexpected	Excav at Tanis and tombs at Luxor. Died unexpectedly on holiday in India
Werbrouck	1889-1959	70	Sudden	Worked at El Kab 1936-38. Suffered fatigue and died suddenly while on holiday
Wiedemann	1856-1936	80	Sudden	Prof of Egyptology, Bonn. Died suddenly
Zaba, Z	1917-1971	54	Sudden	Long career of excavation at Abusir; died suddenly in Prague