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Scanning the Pharaohs

CT Imaging of the New Kingdom Royal Mummies

Zahi Hawass
and Sahar Saleem

AUC PRESS

A gripping analysis of the results of the groundbreaking imaging technology used to examine the royal mummies of the New Kingdom, by leading experts in the field

About the book:

The royal mummies in the Cairo Museum are an important source of information about the lives of the ancient Egyptians. The remains of these pharaohs and queens can inform us about their age at death and medical conditions from which they may have suffered, as well as the mummification process and objects placed within the wrappings.

Using the latest technology, including Multi-Detector Computed Tomography and DNA analysis, co-authors Zahi Hawass and Sahar Saleem present the results of the examination of royal mummies of the Eighteenth to Twentieth Dynasties. New imaging techniques not only reveal a wealth of information about each mummy, but render amazingly lifelike and detailed images of the remains. In addition, utilizing 3D images, the anatomy of each face has been discerned for a more accurate interpretation of a mummy's facial features. This latest research has uncovered some surprising results about the genealogy of, and familial relationships between, these ancient individuals, as well as some unexpected medical finds.

Historical information is provided to place the royal mummies in context, and the book with its many illustrations will appeal to Egyptologists, paleopathologists, and non-specialists alike, as the authors seek to uncover the secrets of these most fascinating members of the New Kingdom royal families.

About the authors:

Zahi Hawass is one of the world's best known Egyptologists, former Egyptian minister of state for antiquities, and National Geographic Explorer-in-Residence. He is the author of many books on ancient Egypt, including *Discovering Tutankhamun: From Howard Carter to DNA* (AUC Press, 2013).

Sahar Saleem, professor of radiology at Cairo University, is a specialist in advanced imaging technology with experience in paleoradiology.

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Introduction

by Zahi Hawass

My interest in the study of mummies began when I excavated the Valley of the Golden Mummies at Bahariya Oasis in 1999. The most important goal of this excavation was the preservation of the numerous mummies that were discovered. This was achieved both by conservation work on the mummies at the site, and by closing down the excavations after three seasons in order to preserve unexcavated remains.

The discovery was very important and became famous, attracting tourists from all over the world who wanted to visit the mummies. To accommodate these requests, I moved a few mummies from the site to a room in the Inspectorate of Antiquities for the tourists to see, and closed the site to the public for the preservation of the remainder of the mummies, which remain in their tombs.

My interest in mummies was reignited when I brought the so-called mummy of Ramesses I from the Michael C. Carlos Museum in Atlanta back to Egypt in 2004. This mummy's story began in the mid-nineteenth century when it was purchased from a family in Luxor for seven Egyptian pounds. The mummy traveled to Canada in 1871 and was exhibited in the Niagara Falls Museum, a collection of curiosities that also included the Daredevil Hall of Fame, located at that time on the Canadian side of the falls.

In the 1980s, the late Arne Eggebrecht, the German scholar who was then the director of the Hildesheim Museum, saw this mummy in the museum and suggested that it could be a royal mummy, based in part on the position of the hands on the chest and the mummy's resemblance to known Ramesside royal remains.

In 1999, the Niagara Falls Museum closed, and its Egyptian collection was offered to the Michael C. Carlos Museum at Emory University in Atlanta. Bonnie Speed, the Carlos Museum's director, and Peter Lacovara, its curator of Egyptian and Nubian art, decided to buy this collection, which included the mummy. In less than two weeks, they mounted a successful campaign, appealing to the citizens of Atlanta to procure the necessary funds to

make the purchase, which was about two million dollars. The mummy was transported to the museum and exhibited there in 1999. Peter Lacovara, with a team of radiologists from Emory University, studied this mummy.[1] The position of the two hands, crossed on the chest, and the style of mummification are similar to that observed on the mummy of Seti I, the son of Ramesses I. When I went to Atlanta to give a lecture and saw the mummy, I was convinced that it is the mummy of Ramesses I. Peter and Bonnie are good people and have a cordial relationship with me. I was able to convince them that a royal mummy cannot be away from Egypt. They agreed to return the mummy, as well as fragments from the tomb of Seti I in the museum's collection.

I journeyed to Atlanta to bring the mummy back to Egypt, accompanied by two of my great friends, Mohamed Farid Khamis and Adel Hamouda. Mohamed is a businessman who owns a carpet factory in Atlanta. He threw a party at the Michael C. Carlos Museum and gave a generous donation of $100,000. My dear friend Adel, a famous writer, also came to attend this event. At the reception, I announced that my gift on behalf of Egypt to the people of Atlanta would be to bring a King Tut exhibition to the city. I kept my promise, and "Tutankhamun: The Golden King and the Great Pharaohs" opened at the Atlanta Civic Center in November 2009. During this very successful exhibit I again traveled to Atlanta and gave a lecture at the Fox Theatre to an audience of 4,500 people.

In preparation for its return to Egypt in 2004, the mummy of Ramesses I was placed in a coffin draped with the American and Egyptian flags, which was received by Bonnie and me during a ceremony in front of the museum in October of that year. At the airport, members of Congress and many young people came to pay their respects and to say goodbye to Ramesses, and a group of young students sang a song of farewell. I escorted the mummy onto an Air France flight, and the captain announced, "We have two important people on our flight today: Ramesses I and Zahi Hawass." A woman seated next to me could not sleep when she heard that there was a mummy on the flight—she was afraid of the mummy's curse.

Ramesses I returned home after 133 years away. He was received at the Cairo airport with all the fanfare befitting a king. Many reporters were there to greet him, and Bonnie Speed and I held a joint press conference at the Egyptian Museum in Cairo to welcome the pharaoh. I decided to send this mummy and that of Ahmose I, the famous Eighteenth Dynasty king who ended the Hyksos domination of Egypt, to be exhibited in the new wing of the Luxor Museum dedicated to the Golden Age of the pharaohs. I journeyed with the two kings to Luxor. Ramesses I was the star, made even more famous because he came from the States, and he was transported to the museum with great celebration. He was welcomed by the governor of Luxor amid dancing and music. Ahmose was relatively neglected, which was strange, since Ramesses I achieved very little in history and ruled for only two years, in comparison with Ahmose, the great king who expelled the Hyksos from Egypt. Both kings are still exhibited in Luxor today.

There were many doubts about the identification of Ramesses I, but recently we took DNA samples from this mummy and also from the mummies of Seti I and Ramesses II (fig. 1). The resulting analysis indicated that the former is his son and the latter his grandson. I

Fig. 1: The mummy of Ramesses II inside the DNA lab of the Egyptian Museum, Cairo.

always maintained our belief that it could be Ramesses I but that the final conclusions should wait until we undertook DNA analysis.

A singular event in my life opened my eyes to the way that mummies are exhibited at museums. In 1972, when I was twenty-five years old, I was asked by the head of Antiquities, Fouad el-Orabi, to give a tour to Princess Margaret of England at the Egyptian Museum in Cairo. As I was explaining the beautiful artifacts, we moved to the west side of the building on the first floor. The mummy of Ramesses II was exhibited in this hall. As we approached the mummy, suddenly Princess Margaret rushed away, covering her eyes. I was astonished and asked her directly, "Why did you do this?" She replied that it was not a good idea to display mummies this way, and that it was disrespectful to the ancient personage. This made an impression on me, and later in my career, I began to look at this idea and see that the way mummies are exhibited in museums is contrary to the spiritual values of the pharaohs. Oftentimes, mummies are shown for a thrill and can frighten children or upset sensitive people.

During a 1979 press conference at the Egyptian Museum, President Anwar al-Sadat addressed the mummy situation. He stated that we could not leave them like this, without proper respect, and suggested either returning the mummies to their tombs or displaying them with more sensitivity. As a young man, I was so happy to see that the president of Egypt had this type of insight. The public, and children in particular, never learn from mummies when they are exposed in this manner. They do not know that mummies and

mummification are science. We can exhibit them, respect them, and understand about their lives and also the achievements of the ancient Egyptians with regard to mummification. We also need to teach our children about the philosophies of life and death of the ancient Egyptians and to help visitors think of the mummies as the remains of individuals, not just as objects of horror or fascination.

In 2002, I was asked by Farouk Hosni, then minister of culture, to be the secretary general of the Supreme Council of Antiquities (SCA, formerly the Egyptian Antiquities Organization). I was not excited about this offer because I was working at the Giza pyramids, the place that I loved. However, I needed to accept the position, because I saw that the SCA was ineffective in its mission and that it was essential that we have good Egyptian archaeologists in the future to direct this council. At the time, we depended completely on foreigners. Our museums were dark and had no educational message. The pharaonic, Jewish, Coptic, and Islamic monuments were deteriorating. I am not going to explain here my overall concept and how I was able to implement it, but I would like to explain my vision concerning mummies and the methods I used to make this vision a reality.

I began by hiring an architect to create a site museum at Bahariya Oasis for the mummies chosen to explain the story of the Valley of the Golden Mummies. The plan of the museum adopted the architecture of the oasis environment. The design is finished, but the museum has not yet been built.

I decided that this was the time to take action to display the Egyptian Museum's mummies in a more respectful manner. I had both short-term and long-term plans to implement this. The short-term plan was designed to break with the old style of the Egyptian Museum and to display the mummies sensitively, with more educational information. We designed two new halls in the museum for the mummies. I also directed the conservation lab to work to preserve them, as nothing had been done prior to this to ensure that their condition did not deteriorate. The royal mummies are now displayed in specialized vitrines with controlled humidity and temperature. Thanks must be expressed to the Getty Conservation Institute for undertaking this scientific project. For the first time, we could see how well the mummies are preserved, and visitors can now understand the lives of these people by reading new information on text and illustrative panels and labels. Before visitors enter each hall, they are presented with information on the cachettes where the mummies were found, and also on death and the afterlife in ancient Egypt. (For the mummies on display, see the appendix, "List of the Royal Mummies in the Egyptian Museum, Cairo.")

For the long term, I issued an order that all the mummies of the pharaohs from Dynasties Eighteen through Twenty should be exhibited at the new National Museum of Egyptian Civilization that we have built in Old Cairo. The museum, which only requires completion of the interior design before it can be opened to the public, is part of a master plan conceived during my tenure as secretary general to construct two new museums in Cairo to complement the existing Egyptian Museum in Tahrir Square. Farouk Hosni, the former minister of culture, was a driving force behind the creation of these two museums. The first, the Grand Museum, is currently under construction next to the Giza plateau. This museum will exhibit the great collections and masterpieces of pharaonic Egypt, such as the treasures of

Tutankhamun. It will also house a conservation lab and storage magazines that will be connected to the museum by a tunnel.

The National Museum of Egyptian Civilization was built in cooperation with UNESCO and is located in a beautiful area in Fustat, Old Cairo, in front of a lake. From its vantage point, one can see the Pyramids, and the churches and mosques of Old Cairo. The museum will explain the broad sweep of Egyptian history from the Predynastic Period to modern times. The Egyptian Museum will continue to house Egyptian art, the great statues to be shown within their archaeological context through photographs and graphics.

I decided that some mummies should be shown inside the Civilization Museum, which would attract many visitors to this new building, because any tourist who comes to Egypt must see three things: the Pyramids, Tutankhamun's treasures, and mummies. The scenario for the exhibition is to display each royal mummy respectfully, with the face covered, in a special vitrine surrounded by text panels explaining all the achievements of the individual, to exhibit with the mummy statues and artifacts of their reign, and to present the results of scientific analysis of the mummy (CT scanning and DNA). In addition, one hall of the museum will be dedicated to illustrating and describing mummification and funerary beliefs through text panels and graphics.

With the two new museum projects underway, I decided to pursue a dream of mine to initiate an Egyptian mummy project, choosing the best scholars in the field of radiology, anatomy, and DNA, and bringing new technology, such as CT scanning and DNA analysis, to study the mummies. This was the first time that royal mummies were studied by CT examination, but this was not the first time that the royal mummies had been studied using modern technology. The first such study was undertaken in 1903, when an x-ray study was performed on the mummy of Thutmose IV. Subsequent studies took place in 1932 and from 1967 to 1971, when all of the royal mummies at the Egyptian Museum were x-rayed. This led to the journey of Ramesses II's mummy in 1976 to France, where it was x-rayed and conserved.

President Valéry Giscard d'Estaing of France asked President Anwar al-Sadat to allow the mummy of Ramesses II to be studied and treated in Paris, because concerns had been raised about the mummy's condition. Actually, many people believed that the reason the mummy traveled to Paris was to determine whether or not Ramesses II was the pharaoh of the Exodus. President Sadat agreed to the examination, and the Egyptian Antiquities Organization (EAO), as it was known then, gave the approval. The mummy was sent to Paris on September 26, 1976, on a French military plane, accompanied by Shawki Nakhla, an Egyptian scientist from the EAO. The mummy was greeted at Le Bourget Airport with the full military honors that a living king would receive, and studies were undertaken in a laboratory at the Musée de l'homme, with the participation of 105 scientists from many other French institutions. The mummy stayed in Paris for more than seven months.

When the mummy returned to Cairo on May 10, 1977, at the airport an Egyptian journalist asked a French scientist who had worked on the project and who had accompanied the mummy on his return to Egypt, if the mummy suffered from any diseases. The French scientist answered that they found a strange insect on the mummy. The reporter said, "Maybe it is a French insect?" Everyone laughed at his reply.

Though these events happened in 1976, I was informed in 2006 that the scientist who treated Ramesses II removed some hair from the mummy. To this day, I do not understand how he was able to do that, because the mummy was accompanied by an Egyptian official. We don't know if the official was complicit in this act or if the samples were taken illegally from this mummy in the Egyptian Museum during the 1975 study, because they did not have permission to take the samples without his knowledge. I found out about it in November 2006, when someone in France put the hair for sale on the Internet for two thousand euros. The seller was a French citizen living in Grenoble who claimed that he inherited these relics from his father, who was a member of the scientific team that examined the mummy of Ramesses II in France in 1976. I moved quickly and was able to contact French authorities through the Egyptian Ministry of Foreign Affairs and also through the efforts of the Egyptian ambassador in Paris, Nasser Kamel. I asked them to retain the pieces, and the French court ruled in our favor. We were able to retrieve remnants of hair, linen bandages, and resin used in the mummification of King Ramesses II. They arrived back in Egypt on April 1, 2007, after having been in France for thirty years. It was a crime for the scientist to secretly remove these things without the consent of the Egyptian government.

I sent Ahmed Saleh from the SCA to France to recover the hair samples. He brought back to Egypt six small samples of Ramesses II's hair along with a larger lock, linen bandages that were once used in the mummification of the king's body, and ten samples of resin from the mummies of Ramesses II and his son Merenptah, a total of forty-one samples. The samples of Merenptah's mummy came into the possession of the Frenchman because the French scientific mission also took samples from this mummy in the Egyptian Museum during a 1975 study. It seems that the French requested to take the samples but their request was rejected; nevertheless, someone from the Egyptian authority apparently allowed them to take forty-one samples from the mummies of Ramesses II and Merenptah in 1976. It is a crime that both the French scientists and the Egyptian scientists who permitted them to take the samples without permission have gone unpunished. In the future we should not permit any scientific expert to work in Egypt without the supervision of an Egyptologist from a respected institution such as a museum or a university to prevent such a thing from happening again.

Additional samples have been taken from other mummies as well. In the mid-1990s, Brigham Young University took samples from ten royal mummies. Permission to do so was given only by the director of the museum and the staff member in charge of the mummies, but permission should have been granted by the Permanent Committee of the SCA as the national antiquities authority. Sadly, any results of this work remain unpublished in a scholarly forum.

My intention was to begin our recent project with non-invasive CT scans of the mummies. Because CT scans produce three-dimensional images and show the soft tissues as well as the bones of the body, it is a much more effective research tool than x-ray examination. Before I could begin to choose the Egyptian scientists who could be members of the Egyptian Mummy Project, a problem to overcome was the acquisition of this

technology. One solution was to approach major television channels that would be interested in broadcasting such a project. By funding our work, in return they could record the process, under our conditions.

I contacted Terry Garcia, the chief science and exploration officer of the National Geographic Society, and explained that we needed to have people contact Siemens, a leading company in healthcare technology, to request the donation of a CT scanning machine to the SCA. Terry is one of the most honest and helpful persons I know, and he has done more important scientific projects for Egypt and National Geographic than anyone. Someday Terry should be rewarded by both institutions. I told Terry if he could help us acquire the machine, we could give National Geographic permission to broadcast the story first, but not exclusively, and also permission to publish it in *National Geographic* magazine. The machine, after that, would belong to the SCA.

I asked Frederick DeWolfe ("Dee") Miller, who is a professor of medicine at the University of Hawaii and a specialist in tropical medicine (he was in Egypt working on a project for the prevention of hepatitis C), to follow up and write the needed proposal to Siemens for the machine. In the end, National Geographic succeeded in bringing the scanner to Cairo, which cost more than a million dollars, and arranging for Siemens to continue to maintain the machine, at the expense of National Geographic. This CT scanner is a trailer-mounted, mobile unit that was (and still is) set up outside the Egyptian Museum.

I decided that we should now, for the first time, have a wholly Egyptian team responsible for the study of the mummies, not under the direction of a foreign team. It was my opinion that we should begin with the nonroyal mummies, but Saleh Bedeir, who was the dean of the Faculty of Medicine and the first member of the Egyptian Mummy Project, proposed that we should begin with the mummy of Tutankhamun, and the SCA Permanent Committee agreed. The CT scanning took place on January 5, 2005 in Luxor.

The scientific team was made up of a group of Egyptian radiologists, pathologists, and anatomists. The team that worked with me in the initial phase of this project was composed of Mervat Shafik, professor of radiology, Faculty of Medicine, Cairo University; Essam el-Sheikh, professor of radiology, Cairo University; Sherif Abdel Fatah, lecturer in radiology, also from Cairo University; Hany Abdel-Rahman Amer, professor in the Department of Animal Reproduction at the National Research Center; Fawzi Gaballa, professor of anatomy, Cairo University; and Aly Gamal Eldin, professor of forensic medicine at Cairo University. I thought that we should also have a foreign team to review the data, and we chose Frank Rühli, professor in the Institute of Anatomy at the University of Zurich; Eduard Egarter-Vigl, director of the Pathology Institute at General Hospital, Bolzano, Italy; and Paul Gostner, director of the Department of Radiology at Central Hospital, Bolzano.

The team stayed almost one month to examine the CT results. Before they completely finished the examination of the data, I heard about a great professor of radiology from Cairo University, Professor Ashraf Selim. In one day, he examined the data from Tutankhamun's mummy and was able to confirm all of the team's findings. He is a genius and a very straightforward person, and we decided that he should be the head of the

team and work with Dr. Amer of the National Research Center and CT specialist, Siemens, Ltd., Egypt, who was in charge of the operation of the machine. The technician was Salah Mohamed Ali.

I believe that, in this introduction, I should explain in more detail Ashraf Selim's role in the Egyptian Mummy Project. He began, as mentioned, in the CT project to scan King Tutankhamun's mummy. Later, he was the sole radiologist involved in the discovery of Hatshepsut's mummy: he recognized the existence of the tooth in the box and collaborated with Dr. el-Behiry to identify the mummy. He continued on to become the head of the CT scanning project of the family of Tutankhamun as well as Ramesses III. I sincerely believe that he deserves full credit for making our project successful.

Our second project was the search for the mummy of Queen Hatshepsut, and we began to think that we should also have a DNA lab to do our own analyses. What is DNA? Deoxyribonucleic acid is a chemical in each cell that carries the genetic instructions for making living organisms. The mitochondria of each cell contain mtDNA, which is passed down from mother to daughter to daughter to daughter. Mitochondrial DNA is also passed down to each son from his mother, but a son cannot pass mtDNA to his children. The nucleus of some cells contains Y-DNA. There is much less Y-DNA than mtDNA in each cell, because Y-DNA is found only in the nucleus. This means it is much more difficult to study. Y-DNA is passed from father to son to son to son, but it is not passed to daughters.

The decision to employ DNA analysis was a difficult one, because I was always skeptical of DNA results. Until recently, it was not possible to get long enough sequences to consider results reliable. Scholars doing this type of analysis in modern labs work with live patients, and contamination of the samples could result. Labs dedicated solely to working with DNA of mummies would bring more accurate results. I realized that the only way to achieve this was again to approach television channels for financial support. We needed to establish two DNA labs and hire the scientists to conduct the studies. Discovery Channel made the best offer, agreeing in return to shoot the result of our work without interfering in the scientific process, and to broadcast their program free of charge on Egyptian TV.

We opened two labs, one at the Egyptian Museum and one at the Faculty of Medicine, Kasr Al-Ainy Hospital, so that each could work independently and confirm the other's results; this is standard in the field. We established an Egyptian team headed by two great scientists, Yahia Gad, professor of medical molecular genetics at the National Research Center and the overall head of the team, and Dr. Somaia Ismail from the same institute. They brought a group of Egyptian scientists consisting of Naglaa Hasan, Rabab Khairat, and Tarek Abdel Aala. The second lab employed three scientists, Abdel Hamid el-Zoheiry and Mohamed Fateen, assistants at the Faculty of Medicine, Cairo University, and Sally Wasef, a scientist from the SCA. I have to thank Ahmed Sameh Farid, dean of the Faculty of Medicine at Cairo University, who helped us establish the second lab at Kasr Al-Ainy Hospital. I would like to emphasize the great work done on the DNA project by Dr. Gad and Dr. Ismail. I went to Luxor with them twice, and I observed how careful they were in extracting samples from

the mummies. The scientific work done by these two scholars was excellent, and they have proved to the world that it is possible to successfully retrieve DNA from ancient mummies.

On April 24, 2007, Dr. Gad did the first sampling on an unidentified mummy. This was executed as a preliminary experiment for testing the DNA sampling procedure before its application to any royal mummy, in addition to providing samples for establishing the lab assays for ancient DNA testing later on. The sampling technique, as Yahia Gad explained in his report, relied mainly on using a bone-marrow biopsy needle to take samples from the deep layers of the mummy through gentle manual burrowing, instead of using automated drilling equipment that may cause considerable damage. Dr. Gad added in his report that trials were made to get more than one sample from the same puncture hole, through the same point of entry but with different angles, thus limiting the number of puncture holes in the mummy.

The scientific team followed the nine criteria for authenticity established by Alan Cooper and Hendrik Poinar to avoid sample contamination and adhere to proper scientific procedure. The samples of DNA were taken first to Lab 1 and then to Lab 2. The results have been studied by the Egyptian team, reviewed by the group of foreign scientists, and published in scientific journals. Carsten Pusch of the University of Tübingen deserves credit for his dedication to the project and his ability to work so well with the Egyptian team. I want to recognize also Albert Zink of the EURAC Institute for Mummies and The Iceman, Bolzano, Italy, for his hard work with us and for his excellent preparation for the publication of the Ramesses III project.

The third major project with the same teams was the study by CT scan of all the mummies that are thought to be connected by familial ties to Tutankhamun, and an attempt to identify family members using DNA analysis. This was followed by another project to discern how Ramesses III died, and to identify the mummy of Unknown Man E (thought to be his son Pentawere) through CT and DNA analyses. Finally, we looked at other Ramesside kings, studying their mummies with the CT scanner alone.

I first met Sahar Saleem, professor of radiology at Cairo University, in early 2007 at a medical conference in Cairo where I gave the keynote lecture. Dr. Saleem had just arrived from Canada, where she was involved in CT studies of mummies as a member of the paleopathology research group at the University of Western Ontario. I invited Dr. Saleem to join the Egyptian Mummy Project, as I anticipated her valuable contribution. Dr. Saleem studied all of the CT scans of the royal mummies of the Eighteenth to Twentieth Dynasties, and provided comprehensive, accurate, systematic analysis of the individual mummies as well as intensive research studies. In addition to her scientific knowledge, Dr. Saleem uses her computer skills in reconstruction and preparation of the CT images. Her input helped in solving mysteries of the feet of King Tutankhamun and the diseases related to his family, and she added new evidence that supports the success of the harem conspiracy against King Ramesses III. Together, we completed and published several CT mummy studies on topics such as the fetuses in the tomb of King Tut, the discovery of new mummification techniques, amulets and jewelry, the spinal diseases of the mummies, and more. For her extensive contribution, I invited her to be the second author of this book.

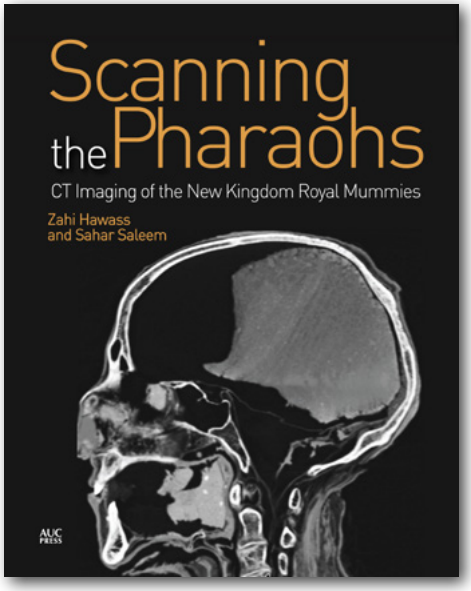
Unless stated otherwise, all of the information written about the CT scans is the research done by Dr. Sahar Saleem. The chapters to which she contributed are as follows: chapter 1 (all); chapter 3 (examination of the mummy of Hatshepsut); chapter 4 (examination of the mummies); chapter 5 (scanning and conclusions; the sidelight was written by both of us); chapter 6 (x-ray and CT scans of the fetuses); chapter 7 (Marfan's Disease); chapter 8 (CT scans of KV21 A and B; the conclusion was written by both of us); chapter 9 (CT examination of the mummies and Merenptah sidelight; the Exodus sidelight was written by both of us); chapter 10 (examination of the mummies and Ramesses III sidelight); chapters 11 and 12 (all); and chapter 13 (all except Tutankhamun's facial reconstruction).

Egyptologist Sue D'Auria edited this book. She is familiar with the mummies because she was a coauthor of the book *Mummies and Magic*, an exhibit at the Museum of Fine Arts, Boston, where she worked for nearly twenty years. She was involved in one of the earliest CT scanning projects, an investigation of the mummies at the MFA. I have to say that she not only worked very hard in editing the English, but also tried to be very accurate regarding references and information. I always accepted her suggestions, and I really have to credit Sue because she was keen to see this book succeed.

I would like to say that the Egyptian team for both the CT scanning and the DNA project, as well as the foreign consultants, worked beautifully together, and with their contributions we were able to make some important discoveries recounted in the book.

This book is just the beginning. With the completion of this first project of CT and DNA analysis, we still have many additional things to do in our second phase, our future line of research. We need to include the study of the mummies of Amenhotep II and Thutmose IV, to compare them to the Thutmosid family. Also, regarding the search for the mummy of Queen Nefertiti, we need to further study the DNA of the two fetuses of Tutankhamun in comparison with the KV21 A mummy, because the primary study indicated that the latter could be Ankhesenamun. If this can be corroborated, then it would be essential to compare the DNA of KV21 A and the mummy KV21 B. At the same time, it will be vital to locate the bones of Queen Mutnodjmet. Finally, we also need in the future to do more DNA analysis on the Ramesside mummies, to gather more information about their lives and deaths.

I hope that you will enjoy reading this new information on the royal mummies, published here for the first time.



Scanning the Pharaohs
CT Imaging of the New Kingdom Royal Mummies

By Zahi Hawass
and Sahar Saleem

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