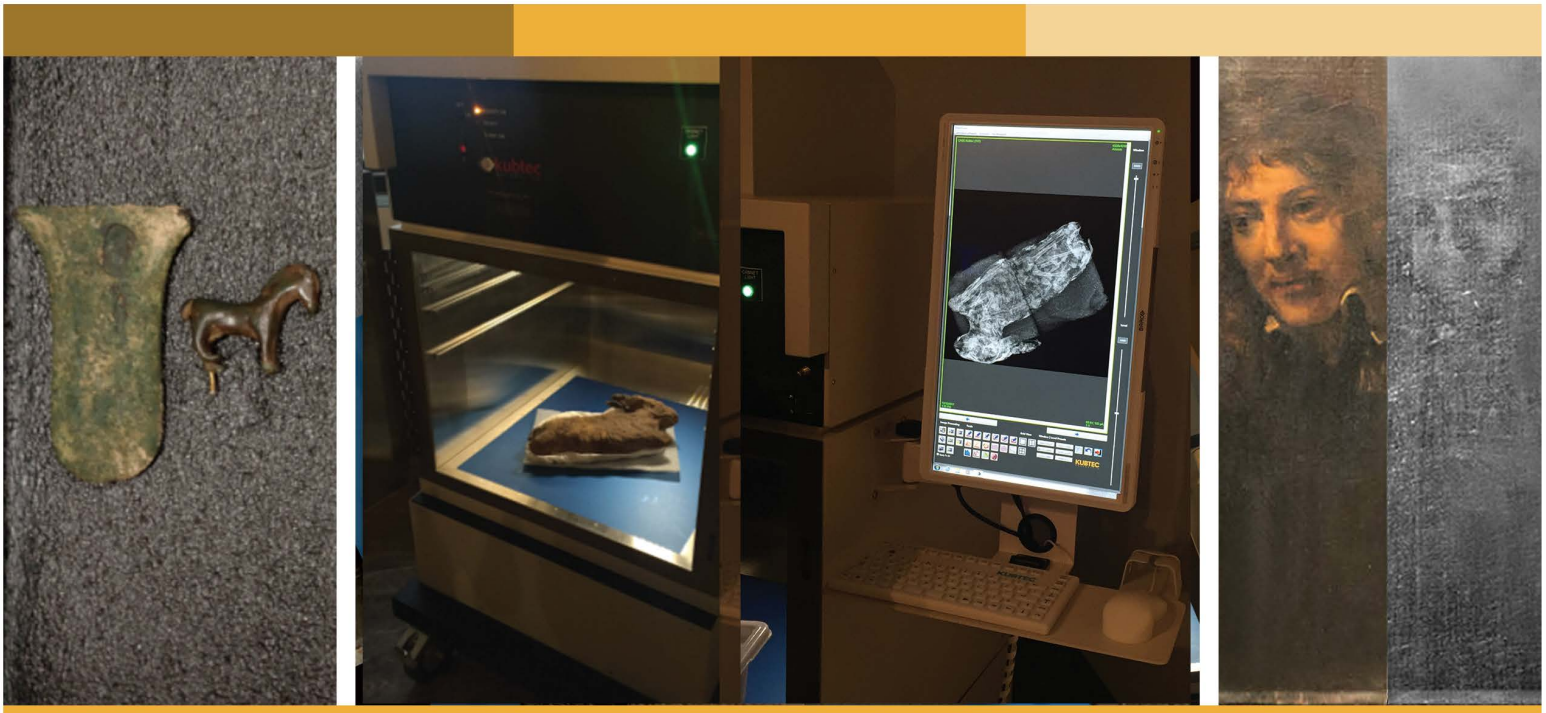

Scientific Analysis Using Digital X-ray Imaging Technology

In the field, lab, museum, morgue, and beyond.

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Figure 1
Mummified quadruped (YPM ANT 6925.001). Came to museum in 1911 from Luxor, identified as young gazelle (Gazella dorcas). Image taken with The XPERT 80-L System's HD optical camera.

Figure 2
Same image as left, x-ray image from The XPERT 80-L System.

Studying Remains

Few individuals would question the role or value of radiography in the study of mummified remains. Major advantages, such as eliminating the superimposition of structures and having the ability to create three-dimensional reconstructions, lead many scientists to trust in multi-detector computed tomography (MDCT) as the best imaging modality for the examination of remains. However, due to the sheer numbers of human and animal mummies in museums, and the difficulties in locating a facility with a unit to carry out the study, it is unrealistic to contemplate scanning every mummy.

Plane radiography should be considered as a valuable alternative. A plane radiography system can be brought into the museum where the mummies are stored, minimizing the possibility of damage by eliminating the need to transport the remains long distances. In addition, since digital systems have replaced film, the images are available in seconds, can be manipulated post-processing, and stored electronically. Nevertheless, portable radiography has a major disadvantage: a radiation protection plan must be developed to minimize exposure not only to the operator of the equipment, but also to others in the area.

An alternative, at least for smaller remains, is a self-contained cabinet x-ray system that is totally shielded to eliminate radiation exposure, such as Kubtec's XPERT® 80 and XPERT® 80-L Cabinet X-ray Systems.

In order to demonstrate the effectiveness of the system, two animal mummies from the Yale Peabody Museum were radiographed at Kubtec headquarters in Stratford, Connecticut.

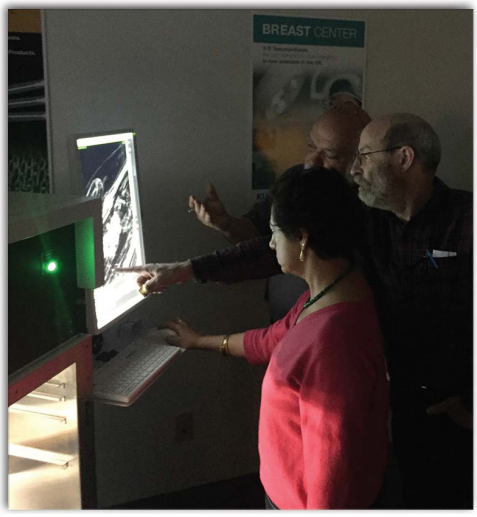
Salima Ikram, Visiting Professor at Yale from the American University in Cairo, brought the remains to Kubtec, along with Roger Colten, Senior Collections Manager at Yale Peabody Museum, accompanied also by Gerald Conlogue, Professor of Diagnostic Imaging and Co-Director of the Bioanthropology Research Institute, Quinnipiac University.

The team noted that animal mummies are typical manifestations of ancient Egyptian religious practices, particularly from c. 600 BC to AD 300. Animal mummies can be divided into five major categories: pet mummies, victual or food mummies, sacred animals, votive animal mummies, and 'other', a diverse group with various interpretations. Votive animal mummies were the most common type and consist of mummified animals that were sacrificed and dedicated to a particular deity, with the idea that they would take the donor's prayer directly to the god, much as a candle in a church conveys a prayer. The Peabody examples are votive mummies.

Figure 3
Mummy inside decorated vessel (YPM ANT 6924.002) arrived at museum in 1915, excavated in Abydos. Package contains body of mature Sacred Ibis (Threskiornis aethiopicus). Imaged using The XPERT 80-L System's HD optical camera.

Figure 4
Same as on left, x-ray image from The XPERT 80-L System.

Studying Remains



A mummified quadruped (YPM ANT 6925.001), probably sacred to the goddess Anuket, a maternal goddess who took particular charge of the king, came to the museum in 1911 from Luxor. It is wrapped in linen in a kneeling position, with details of the face painted on, with the tail painted reddish brown. The imaging allows us to see beneath the wrappings and to identify the animal as a very young gazelle (Gazella dorcas), probably less than two months of age. As it was so young, it had no horns, but, in order to give it the appearance of a gazelle, the embalmers made false horns of some sort of plant material, possibly reed, which were wrapped in linen and then painted. It was eviscerated, as is normal in mummification, and wrapped in at least four layers of linen bandages and a shroud **(figures 1-2).**

The second mummy takes the form of an elaborately wrapped teardrop shape (YPM ANT 6924.002). The back is plain, but the front is decorated in a pattern of rectangular coffers crafted out of textile. It arrived in the museum in 1915 and had been excavated in Abydos. The extraordinarily clear images show that the package contains the body of a mature Sacred Ibis (Threskiornis aethiopicus), a bird sacred to Thoth, the god of writing and wisdom. The bird was mummified with its head and beak extended along its stomach. Although the ibis had been eviscerated, its gizzard, full of semi-digested food, had been returned to the body cavity so that it would not be hungry in the afterlife. Images show fragments of plant material, and possibly the remains of fish vertebrae and snail shells, part of the diet of a bird that spent its life along the banks of the Nile **(figures 3-4)**.

"Kubtec's extraordinary technology made it possible for us to non-destructively study and learn about these enigmatic mummified packages that have been in the Peabody Museum collection for more than a century."

-Salima Ikram

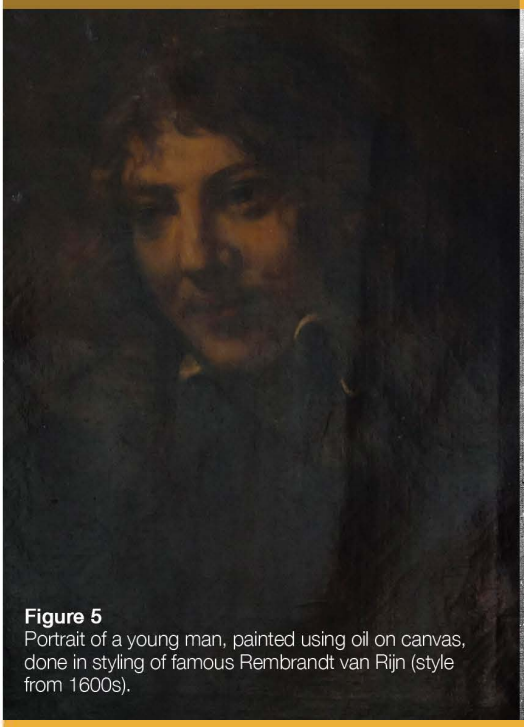


Figure 5
Portrait of a young man, painted using oil on canvas, done in styling of famous Rembrandt van Rijn (style from 1600s).

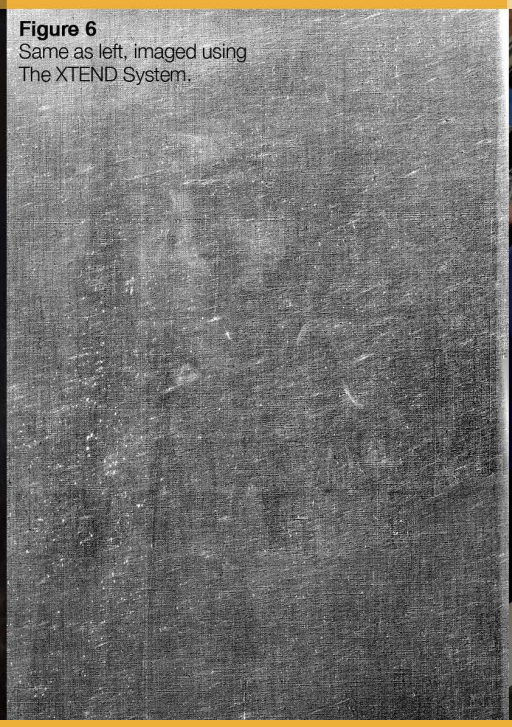
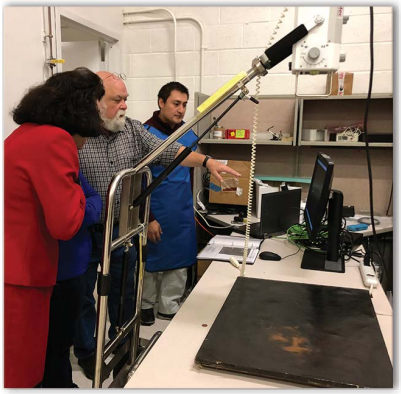


Figure 6
Same as left, imaged using The XTEND System.

Researching History



Digital X-ray imaging is a powerful tool often used in the field or lab for art examination and forgery investigation. When Kubtec's high-resolution X-ray equipment was utilized to study a work of art obtained at an auction by a nationally known art historian, new details which were previously obscured were revealed, leading to exciting conclusions about the piece's origin. Jerry Conlogue, Professor of Diagnostic Imaging at Quinnipiac University, provided expert assistance during the hands-on study **(see figures 5-6)**.

The portrait of a young man was painted using oil on canvas, in the styling of the famous Rembrandt van Rijn. The subject is Nicolaes Bruyningh, Law Student/Clerk b., 1630 – d. 1680 (original Nicolaes Bruyningh, 1652, Kassel Germany).

Using the Kubtec XTEND® Portable High Resolution X-ray System, the team took several images of the painting and was able to make the following important determinations.

The radiograph showed the density of the paint used in certain sections, specifically in the facial area of the nose, cheeks, forehead and the tassels from the collar. It also showed other details obscured by surface dirt and old varnish, not evident without the radiograph.

Additionally, the radiograph showed in intricate detail the weave of the canvas, with thicker threads and thinner threads at consistent intervals. The experts noted that the canvas may not be of the highest quality due to the weave construction, commenting that artists often end up in hardship at certain times in their life and must resort to using whatever canvas and materials are available within their means.

With no signature nor date on the painting itself, the experts concluded that the artwork is less likely to be a deliberate forgery. Rather, the piece may have been painted by a student of the master, another artist who admired Rembrandt's work, or even, in a farther reaching conclusion, by the master, himself.

The investigators were excited about their new findings and concluded that there are more facts to be discovered and more analysis to be done before the full history of the piece can be learned.

> "Many important clues were *not evident without the radiograph... the radiograph shows intricate detail... questions have been answered, it now opens the door to new questions.*"
>
> *-Christina L. Pereiro, SPA*

Figure 7
Some pieces from the 3500-year-old Griffin Warrior Tomb discovered and excavated by Stocker's team in Pylos, Greece

Analyzing Burial Sites

One of the greatest challenges faced by archeologists worldwide is having to do their careful analysis right in the field--often not in the best of conditions--so as not to disturb the site nor its precious contents. This was the problem faced by the international research team that discovered and excavated the 3500-year-old Griffin Warrior Tomb in Pylos, Greece.

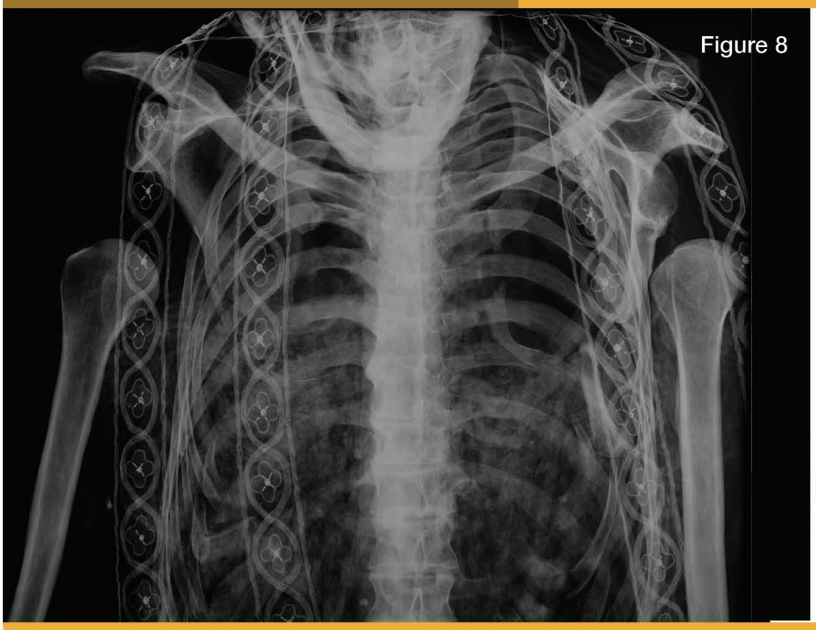
Dr. Sharon Stocker, Senior Research Associate in the Department of Classics at University of Cincinnati's McMicken College of Arts and Sciences, who co-led the research team from UC, describes it as "one of the most magnificent displays of prehistoric wealth discovered in mainland Greece in the past 65 years." The remains of the prominent warrior were found on the floor of the tomb, weapons to his left, jewelry to his right.

Grave gifts included, near the head and chest of the man, a sword with a golden hilt, and a gold-hilted dagger beneath it. Other weapons were also found by the legs and feet. Gold cups rested on his chest and stomach. By his right side were hundreds of carnelian, amethyst, amber, and gold beads, a gold chain and a pendent, dozens of seal-stones carved with intricate designs, and four gold rings.

A plaque of ivory with a representation of a griffon in a rocky landscape lay between the man's legs, and nearby was a bronze mirror with an ivory handle, among other artifacts (to learn more about the find, visit the official site at www.griffinwarrior.org).

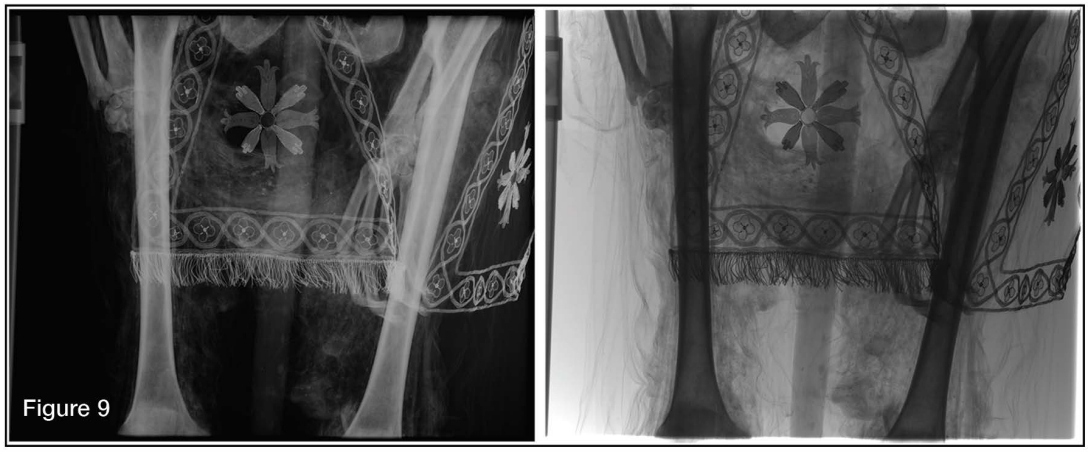
Kubtec welcomed Stocker, and once again, Professor Jerry Conlogue, to the Stratford, CT research and manufacturing facility where they selected the proprietary XTEND™ Portable X-ray unit to image some of these precious findings in hopes of unlocking unsolved mysteries about the ancient civilization.

After her trip to Kubtec's Stratford facility, Stocker confirmed the need among the archeological community for high resolution digital X-ray equipment that is portable, robust, and simple to use. Kubtec was pleased to announce being chosen as the official X-ray provider for Shari Stocker's team. The equipment will be used to further study this once-in-a-lifetime archeological find (figure 7).



Examining Mummies

The Ganji Mummies, Bari, Sicily: The Gangi mummies are a unique group of preserved human remains from the burial crypts of the Mother Church of Saint Nicolo of Bari, Sicily. Dating from the early 18th through the 19th centuries, the mummies are referred to as the 'waxed mummies," as the faces have wax-like masks, likely used to give a more life-like appearance. Until recently, none of the mummies in the Gangi group had been scientifically examined. Professor Conlogue and his team used the Kubtec XTEND Portable Digital X-ray System to examine the mummies. The images clearly show not only the hard and soft tissue of the mummies but also the individual threads of their vestments. (Figures 8-9)



Las Momias de las Guanajuato, Mexico: The Museo de las Momias de Guanajuato is a world renowned Museum located in the hilly, colonial city of Guanajuato, about a four hour drive north of Mexico City. It houses the largest group of naturally mummified remains in the western hemisphere and represents individuals that died over a one hundred year period. The group provided a unique opportunity to study a longitudinal sample of mummified remains with the potential to provide information regarding bioarchaeological factors effecting the population during that period. Conlogue and his team used the Kubtec XTEND Portable Digital X-ray System to record the fine details of the mummified remains. Because of the wide latitude of the XTEND System, it was possible to not only visualize the skeletal elements but also soft tissue, cartilaginous rings on the trachea and the carina. (Figure 10)

KUBTEC Digital X-ray systems are designed for Archaeological, Forensic and Scientific studies.

The fine resolution of Kubtec detectors reveals more clues to better determine a cause of death; mummification methods; age and sex determination via examination of pelvis and/or jaws and teeth; examination of mummified soft tissues; chest and rib cage; infant skulls; measurement of arthritis progression; and gross examination of subject without dissection.

Additionally, Kubtec systems feature easy portability to any locale, simple workstation setup, onsite and rapid image availability, compact size and high output which facilitates penetration of the majority of subjects.

Kubtec Systems are durable and may be utilized in high or low humidity and heat conditions (systems have been utilized in the open desert, museums, the sarcophagus, and caves).

The PARAMETER 3-D™ Tomosynthesis System

Multislice radiography for imaging. Comprehensive software packages for analysis.

The XTEND™ Portable X-ray System

In the field or morgue, NDT or lab use, only this system can provide fast, on-site imaging with high-resolution, rapid display.

The XPERT® 80-L Cabinet X-ray System

When you need superior imaging for detailed analysis and investigation, with detector sizes up to 17” x 17” (or 43 x 43 cm).

About Kubtec

At Kubtec®, our passion is designing innovative digital X-ray systems that meet customer needs for clinical, scientific, forensic, agricultural, and industrial applications.

Our versatile and expanded product lines include: digital specimen radiography, cabinet X-ray systems, Flat Panel Detectors, non-isotope-based irradiators, portable X-ray systems, and conveyorized X-ray machines.

Our comprehensive image analysis packages include Seed Counting, Bone Mineral Density, and 3-D Tomosynthesis imaging.

All Kubtec® digital X-ray products are made with pride in the USA.

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