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Radiography and Replication as Investigative Tools for Conservation Research:
The Dummy Mummy Project

Introduction

This paper presents the results of technical research carried out during an independent study¹ at The Sherman Fairchild Center for Objects Conservation at The Metropolitan Museum of Art in Fall 2013. The course focused on developing expertise in producing and interpreting conventional and digital X-ray radiographs. Radiography has been used for over a hundred years as a powerful tool in the technical examination of works of art. Material differences, manufacturing techniques, and past restorations, often readily apparent in a radiograph, may confirm visual observations or reveal otherwise unobtainable information.

Corn mummies, the specific class chosen for the in-depth investigation presented here, although studied by Egyptologists, have not received much attention in the laboratory. The Metropolitan Museum has two corn mummies in its permanent collection and a third on long-term loan from an anonymous donor. The loan object (L1991.11), referred to as Corn Mummy 1, was the first to be examined. It is housed in a distinctive brightly painted coffin. The other two examples, 58.98 (Corn Mummy 2) and 58.106.1 (Corn Mummy 3) are similar with their dark, monochromatic exteriors.

Historical Background

Sometimes misidentified as ‘infant mummies’ or ‘falcon mummies,’ Egyptian corn mummies constitute an idiosyncratic category of mummies that date to the first millennium BC. They are generally housed in mummiform falcon coffins ranging in size from 35 to 50 centimeters. These essentially pseudo-mummies contain grain rather than mummified human or animal remains. They embody concepts relating to regeneration and the god Osiris. The variation of form suggests that these objects were produced in a variety of locations and/or over a long period of time. Maarten Raven, an Egyptologist in the Netherlands, published the first technical study of corn mummies in 1982.²

Despite their name, there is no corn in these mummies as corn is strictly a New World grain. The term comes from the German, *Kornmummien*, which is consistent with a more generic British English usage. Grain is a logical component for a totem related to regeneration,

¹ The class was supervised of Deborah Schorsch, Objects Conservator at The Metropolitan Museum.

² Raven, Maarten J., “Corn-Mummies,” *Oudheidkundige mededelingen* 63, 7-38. Leiden: National Museum of Antiquities, 1982. This article published the two examples at The Metropolitan Museum of Art (A, B, page 38), along with six other examples in other collections.

performing several symbolic roles: grain is regarded as the staple food in ancient Egypt and cereals are considered living and changing substances of a cyclical nature. The lifecycle of grain parallels the dying and reincarnation of Osiris and reaffirms the concepts of resurrection and revival.

There are few examples of excavated corn mummies and scholars have generally categorized these objects based on stylistic similarities rather than technical investigation of their contents. The decoration of the coffins, the shape of the mummiform bundle, and a presence of associated objects such as royal scepters, crowns, and divine beards, can all be associated with Osiris and the treatment of the dead as related in magical spells and texts such as those found in the Book of the Dead.

Related objects called corn mummy molds or “Osiris beds” have been found as well, with a notable example discovered in the tomb of King Tutankhamen.³ These recessed molds in the shape of Osiris consisted of a bed of linen with soil and seeds, which, once watered, would sprout and thereby symbolize regeneration. Osiris beds have been thought a possible precursor to corn mummies, although that opinion has been challenged recently. Some scholars have proposed that the latter played a votive role during the annual Osiris Festival that took place in Dendera during the month of Khoiak.⁴ Others have suggested that corn mummies may be associated with the cult of Osiris cult at Abydos.⁵ These assertions are difficult to prove, in no small part because no excavated corn mummies from Dendera or Abydos have been recorded.

In her dissertation on corn mummies, Maria Centrone, an Egyptologist at the University of Durham, England, included ninety-six known corn mummies in her catalog.⁶ The proveniences of many of these are undocumented, but some are linked to excavations at Tehne, Meydum, el-Sheik Fadl, and in the Tuna el-Gebel area. Other corn mummies have been attributed to these find spots based on stylistic similarities. On this basis, Corn Mummy 1 can be

³ Carter Excavation, Carter No. 288a, Burton photograph p1054, <http://www.griffith.ox.ac.uk/php/am-makepage1.php?&db=burton&view=gall&burt=&card=288&desc=&strt=1&what=Search&cpos=4&s1=magename&s2=cardnumber&s3=&dno=25>

⁴ Centrone, Marie Costanza. “Corn-Mummies: A Case of “Figuring It Out.” In *Proceedings of the Ninth International Congress of Egyptologist, Grenoble, 6-12 September 2004*, edited by Jean-Claude Goyon and Christine Cardin, 293-301. Leuven, Paris & Dudley MA: Uitgeverij Peeters Publishers and Booksellers Inc., 2007.

⁵ Schulz, Regine. “A Corn Mummy Decoded.” *The Journal of the Walters Art Museums* 63(2009): 5-14.

⁶ Centrone, Maria Costanza. *Egyptian Corn-mummies: A class of religious artefacts catalogued and systematically analysed*. VDM Verlag Dr. Müller, 2009.

grouped with those associated with the Tuna el-Gebel site, by comparison to the example at the Brooklyn Museum and two others at the Rijksmuseum van Oudheden in Leiden published in Centrone's dissertation.⁷ The other two Metropolitan Museum corn mummies lack proveniences.⁸

Within the corn mummy corpus, there is considerable variation in the painting on the coffin, which may have elaborate polychrome designs or be painted a solid color, frequently black. Maria Centrone discussed color symbolism in her categorization of the corn mummy coffins. The ancient Egyptians generally associated white with cleanliness, sanctity (mummies were wrapped in white linen), and light, with its natural animating power. Black, on the other hand, was linked to death and resurrection. Yellow and gold signified the sun and life while green symbolized vitality and rebirth. Hieroglyphs, such as spells from the Book of the Dead, provide textual insight and are incorporated into the decorative programs.

Examination and Analysis

Interest in this class of objects was generated by the puzzling appearance of radiographs made during the initial examination of Corn Mummy 1. All three corn mummies at The Metropolitan Museum of Art were subsequently investigated visually and radiographed; they were analyzed using X-ray fluorescence (XRF) and scanning electron microscope (SEM) and mummy replicas were produced, all with the goal of the understanding of these enigmatic objects.

As noted earlier Corn Mummy 1 is housed in a polychrome painted wooden coffin (Figure 1). The bundle inside the coffin is roughly cylindrical. The dark resin-coated wrappings are covered with a finer textile fragment that was tied at the head and foot. In the radiograph (Figure 2), the bundle contents appear relatively homogenous and the layers of textile wrappings are readily apparent. The various pieces of wood that were used to construct the coffin are visible in the radiograph of the lid. A series of radiographs was taken at different exposures and angles to try and learn as much information as possible. In the end, the materials inside the mummy itself could not be identified. Research for analogous objects was undertaken to help clarify our observations.

⁷ Centrone, *Egyptian Corn-mummies*, 46-51.

⁸ Centrone, *Egyptian Corn-mummies*, 68-70.

For example, the coffin of a corn mummy on loan to the Brooklyn Museum (2007.1a-c; Figure 3) is strikingly similar in style to that of Corn Mummy 1. The mummy bundle of the former, however, was more Osirid in shape. In a radiograph taken by Brooklyn Museum conservators (Figure 4), the contents are homogenous in appearance with the outlines of the textile wrappings visible on the edges. No inclusions were observed. Although the Brooklyn Museum corn mummy appears to be similar to Corn Mummy 1, the contents of both bundles were unrecognizable. The investigation continued with the two examples in the Metropolitan Museum's permanent collection.

Instead of brightly colored, complex imagery, the coffins of Corn Mummy 2 and Corn Mummy 3 are painted entirely brownish black, relieved only by incised/painted hieroglyphs. As for the mummies themselves, care had been taken to wrap the bundle in an anthropomorphic shape. A wax mask with green face and yellow-brown crown had been placed over the "head" of each pseudo-mummy. Although absent from the two corn mummies in polychrome coffins previously described, such wax masks generally are present on the other published examples.

In ancient Egypt, wax was valued for its magical and defensive properties.⁹ Its plasticity allowed for the features and crown of Osiris to be easily formed, and wax was also used to create the smaller objects such as the royal scepters, uraei, and images of the Four Sons of Horus that are sometimes included in corn mummy coffins. Wax amulets could be placed over the mummiform figure for defensive and regenerative purposes, just like for human mummies. These wax accessories are found in abundance on one example at the British Museum (EA41553). At this point it is unclear whether the presence or absence of such wax additions may indicate a time or place of manufacture.

Ann Heywood, an objects conservator at The Metropolitan Museum, performed a technical examination of Corn Mummy 2 in 1987 (Figure 5). The resinous material on the linen wrappings was identified as bitumen using by infrared (IR), energy-dispersive X-ray spectroscopy (EDS), and from the scent of a sample when heated. Beeswax, identified with IR, was used for Osiris mask. A copper pigment was added to tint the face and beard green and an arsenical pigment, probably orpiment, for the yellow crown. Elemental analyses of the colorants were carried out with EDS. Heywood noted that the upper layer of the crown had darkened and

⁹ Raven, Maarten J. "Wax in Egyptian Magic and Symbolism." *Oudheidkundige mededelingen* 64, 7-47. Leiden: National Museum of Antiquities, 1983.

discolored to brown. A white powdery layer on top of the crown was also noted but not identified.

Although there already are conventional film radiographs of Corn Mummies 2 and 3, new digital radiographs were made so that all three mummies were radiographed with the same equipment using the same operating conditions. The Osirian-shaped buddle of Corn Mummy 2 has a uniform but slightly marbled texture (Figure 6). Mummy 3 is in poor condition (Figure 7), and in the radiograph, the wax mask shows up surprisingly well, especially in areas where the underlying mummy body is missing (Figure 8). The mummiform figure where it survives is mottled with even larger inclusions. Although the damage to the mummy is unfortunate, for purposes of the material investigation, having access to the interior of the mummy was very informative: the inclusions could easily be recognized as cereal grains within a matrix of sand mixed with soil and/or clay. Archaeobotanists at the Archaeological Museum of Cracow have identified two grains that were used in corn mummies: hulled barley and emmer wheat.¹⁰ Both these cereals were grown along the banks of the Nile River and were important crops for the ancient Egyptians. Based on comparison with published drawings and photographs in the Cracow Museum study, the grain inside Corn Mummy 3 is likely to be barley.

Elemental analysis of the wax mask of Corn Mummy 3 was carried out by XRF to determine what colorants might be present on the crown, since it displayed a brownish-red upper layer, but in areas of loss, a lighter yellow color underneath was visible. There was particular interest in identifying any pigments used for the crown, since it displayed a brownish-red upper layer, but in areas of loss, a lighter yellow color was visible below (Figure 9). Surface analysis of the green beard, the yellow uraeus, and the yellow crown were carried out using XRF. The green wax unsurprisingly has with strong copper peaks, perhaps from malachite. All three spectra taken of the yellow wax have very strong arsenic peaks. Given what is known about ancient Egyptian painting practices, an arsenic sulfide mineral such as orpiment was suspected.

¹⁰ Wasylikowa, Krystyna and Andrzej Jankun. "Identification of Barley from the Ancient Egyptian Corn-Mummies in the Archaeological Museum in Cracow." *Materialy Archeologiczne* Tom XXX (1997): 13-15. For the Cracow corn mummies, sycamore wood was used for all three coffins. The choice of sycamore wood is related to both its availability and its symbolism. According to Centrone, sycamore trees were part of the ancient Egyptian iconography for representing the divine world. They were considered manifestations of the goddesses Nut, Isis, and Hathor who all offered nourishment and libation to the dead. Coffins made of sycamore wood were regarded as protective enclosures where the deceased could wait for the journey to the afterlife.

Orpiment had also been suspected as the pigment coloring the wax crown on Corn Mummy 2 (58.106.1), since arsenic was likewise identified with SEM-EDS in Ann Heywood's analysis.

A sample examined using SEM-EDS by Federico Caro, Conservation Scientist at The Metropolitan Museum, confirmed that orpiment was indeed used as the yellow pigment on the wax mask. Whereas broad elemental analysis indicated the presence of arsenic and sulfur, an actual particle could be identified from its stoichiometry, and more tellingly, from its lamellar structure, as the arsenic trisulphide orpiment (As_2S_3).¹¹ Another particle had an arsenic-to-sulphur ratio that was close to one-to-one. This is a better match for realgar or its alteration product, pararealgar (As_4S_4), which are both attractive possibilities because they are red and orange respectively. It is possible that the orpiment used contained realgar as an impurity, but another explanation is more likely: the particle may be a deterioration product of orpiment with diminished sulfur. In fact, the characteristic laminae of orpiment are also present this second particle. A third particle visible in the SEM image, cubic in form, is actually a white arsenical oxide, arsenolite (As_2O_3), which may represent an end product of this deterioration process (Figure 10). In retrospect, the powdery white layer on the crown of Corn Mummy 2 that Heywood thought might be a waxy bloom, could also be a deterioration product of the yellow pigment.

In addition to being represented as white, the crown of Osiris can also be depicted as gold. An example of Osiris with a gold corn can be seen on a painted statuette (JE 12-11-25-3) at the Egyptian Museum in Cairo. Perhaps a 'golden' crown was the desired appearance for the wax mask associated with Corn Mummy 2 and therefore the degradation of orpiment would not be surprising. More research would need to be undertaken to prove this theory.

The Dummy Mummies

Understanding of how the mummies were made, and how they could be more successfully interpreted when direct examination was not possible, led to the replication experiments. Three small "dummy mummies," were made each containing pearled barley, sand, or dirt, as well as a fourth mummy containing a mixture of all three (Figure 11). The contents were wrapped in linen that was secured with an adhesive. The radiograph (Figure 12) shows that sand is more radiopaque than the rest of the materials, with the exception of some radiopaque

¹¹ RRUFF Database, "Orpiment", <http://rruff.info/chem=As,S/display=default/R060105>

inclusions in the potting soil that was used, for lack of a more authentic Egyptian dirt. The fine sand, furthermore, contributed to the overall radiopacity of the dummy mummy made of all three materials. As expected, the barley itself produced a granular pattern overall. The folds of the linen in the sand dummy mummy are quite visible where the sand was not evenly distributed. This venture into the radiography of experimental replicas proved very informative as the various components could be isolated and radiographed individually.

After the damaged Corn Mummy 3 was carefully examined another Osirid “dummy mummy” wearing a wax mask was made, also based on the experience with the first replicas. This “body” of the mummy was made with a mixture of barley, sand, clay and dirt, sifted to remove the large inclusions, wrapped with linen strips soaked in asphaltum. An Osiris face and crown were sculpted in clay and used to cast a plaster mold.¹² Beeswax colored green with malachite and yellow with orpiment was pressed into the plaster mold. The shape was smoothed and finished with a tacking iron and the protruding beard and uraeus were added (Figure 13). The radiograph of this final ‘dummy mummy’ proved to be a close approximation to the Metropolitan Museum Corn Mummies 2 and 3 (Figure 14). Similar granular and marbled patterns were observed on the ancient corn mummies and the final Osiris ‘dummy mummy.’

Conclusions

Understanding the construction of composite objects can be a challenge to conservators. In this case, curiosity about these idiosyncratic objects was related to interest in the symbolic meaning of the various materials employed. Making replicas has several positive consequences: not only does one gain an understanding of the working properties of unfamiliar materials; replication experiments of this kind reduce destructive investigations, such as the mummy unwrappings of the past. Although the practice is now considered unethical, one can sympathize with the innate desire to know what was wrapped inside. Radiography, while it remains an essential tool for conservation research, was limited in what it could reveal about these objects. However, used in conjunction with the replicas it proved a powerful tool. Although much was learned from earlier studies and the investigations described herein, the manufacture of these

¹² That the wax masks were cast rather than modeled directly was suggested by Meg Craft’s analysis of the corn mummy on loan to the Walters Art Museum.

objects could only be understood when considered with information obtained through the making and radiographing the replicas.

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Figure 1- Corn Mummy “1” (L1991.11)
Courtesy of The Metropolitan Museum of Art



Figure 2- Corn Mummy “1” (L1991.11), X-ray radiograph (45 kV, 5.0 mA, 32 s)
Courtesy of The Metropolitan Museum of Art



Figure 3- Corn Mummy (2007.1a-c)
Courtesy of the Brooklyn Museum



Figure 4- Corn Mummy (2007.1a-c), X-ray radiograph
Courtesy of the Brooklyn Museum



Figure 5- Corn Mummy “2” (58.106.1)
Courtesy of The Metropolitan Museum of Art

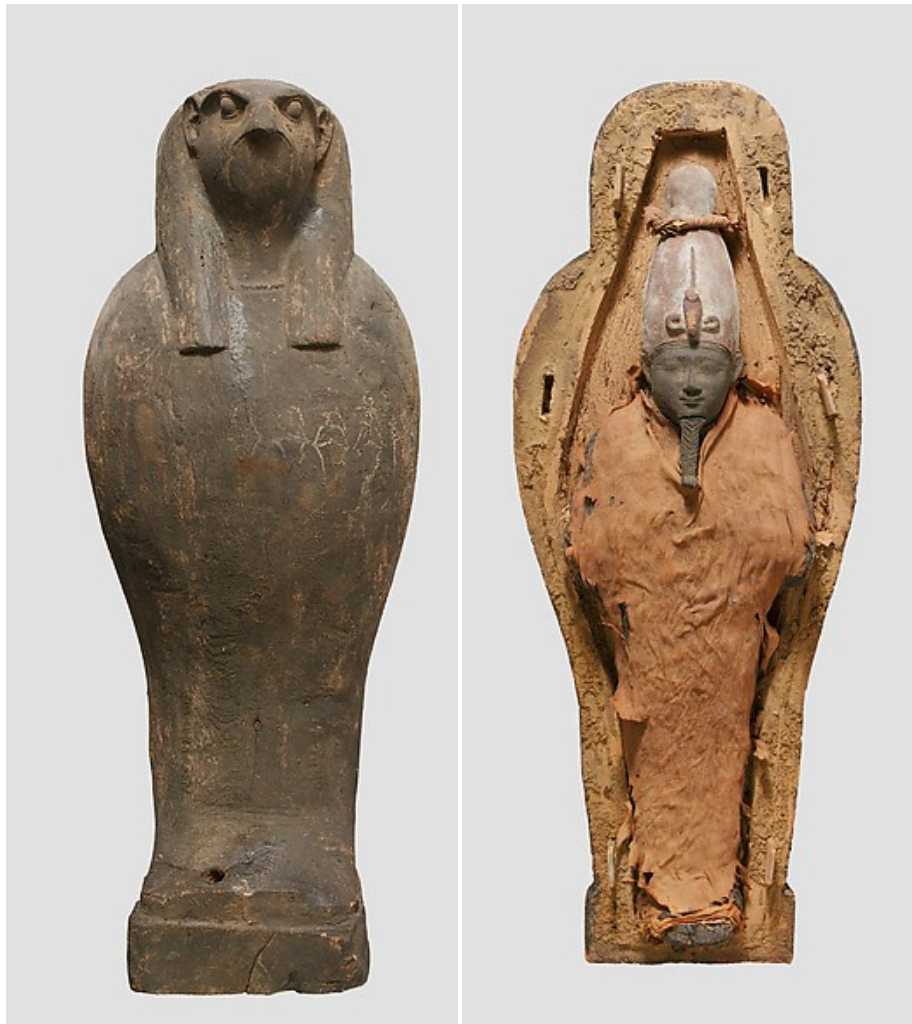


Figure 6- Corn Mummy “2” (58.106.1), X-ray radiograph (45 kV, 5.0 mA, 30 s)
Courtesy of The Metropolitan Museum of Art



Figure 7- Corn Mummy “3” (58.98)
Courtesy of The Metropolitan Museum of Art



Figure 8- Corn Mummy "3" (58.98), X-ray radiograph (45 kV, 5.0 mA, 30 s)
Courtesy of The Metropolitan Museum of Art

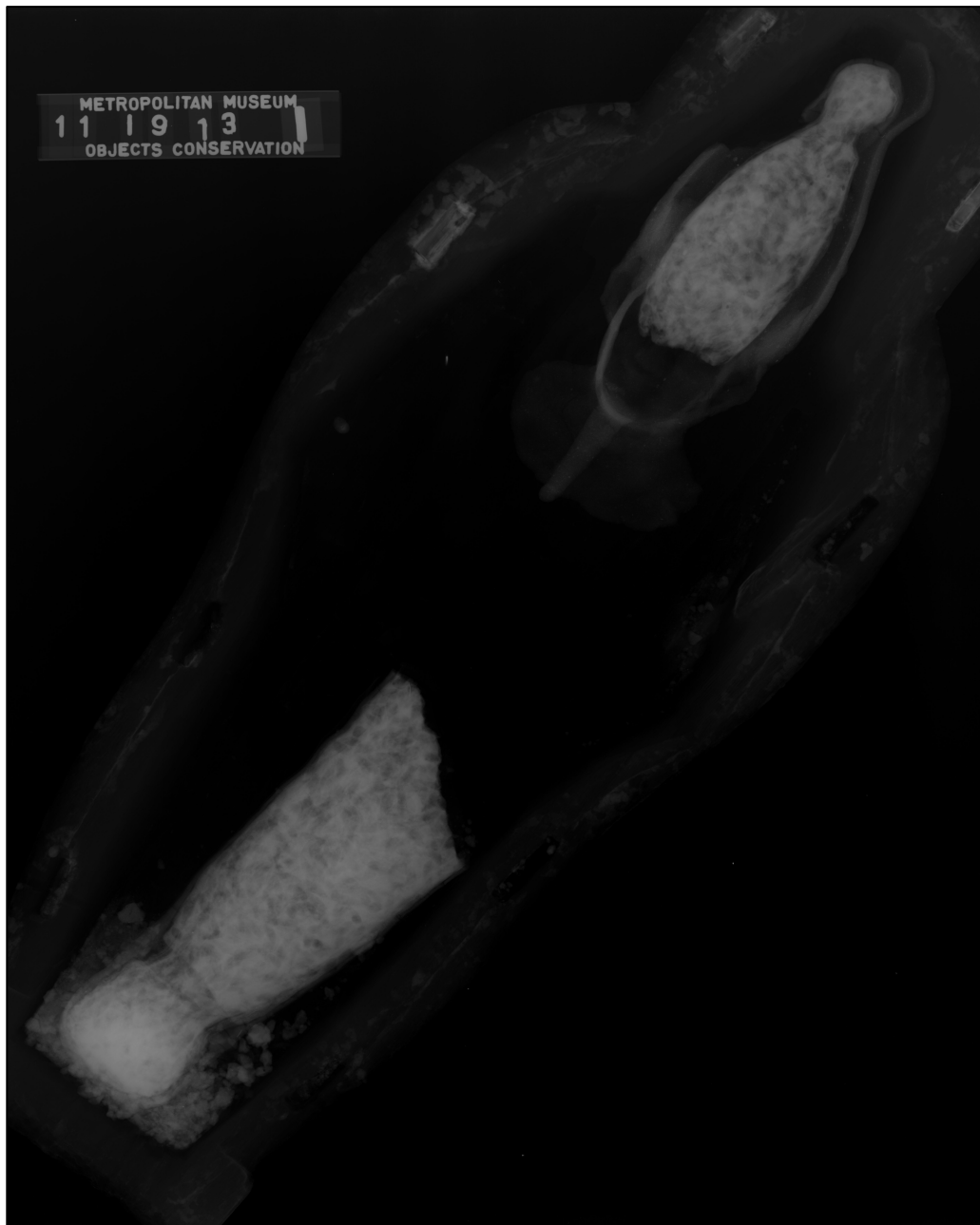


Figure 9- Corn Mummy “2” (58.98), Detail of different color wax
Courtesy of The Metropolitan Museum of Art



Figure 10- Corn Mummy “3” (58.98); Annotated SEM image
Courtesy of The Metropolitan Museum of Art

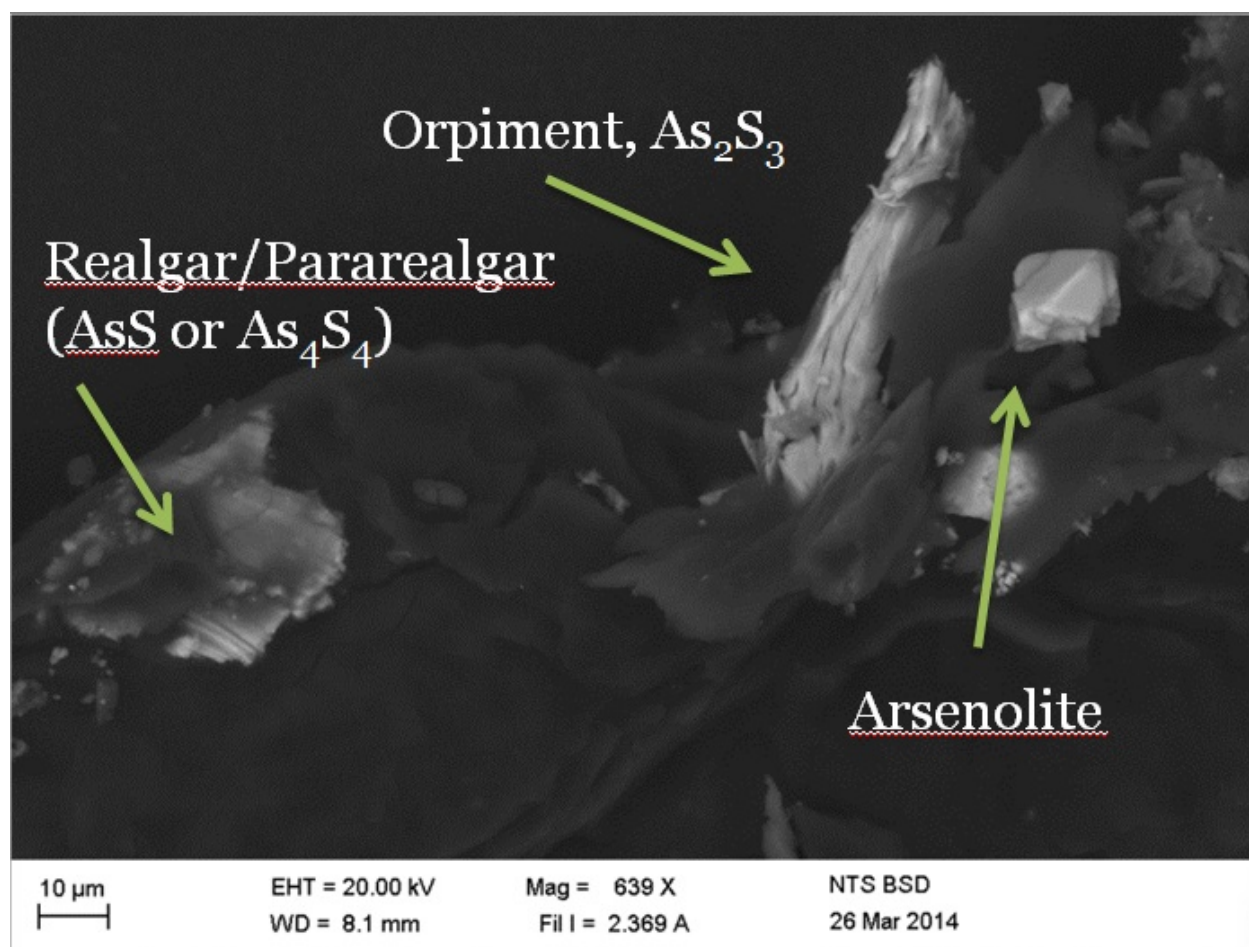


Figure 11- Four Dummy Mummy Replicas



Figure 12- Four Dummy Mummy Replicas, X-ray radiograph (35 kV, 5.0 mA, 30 s)

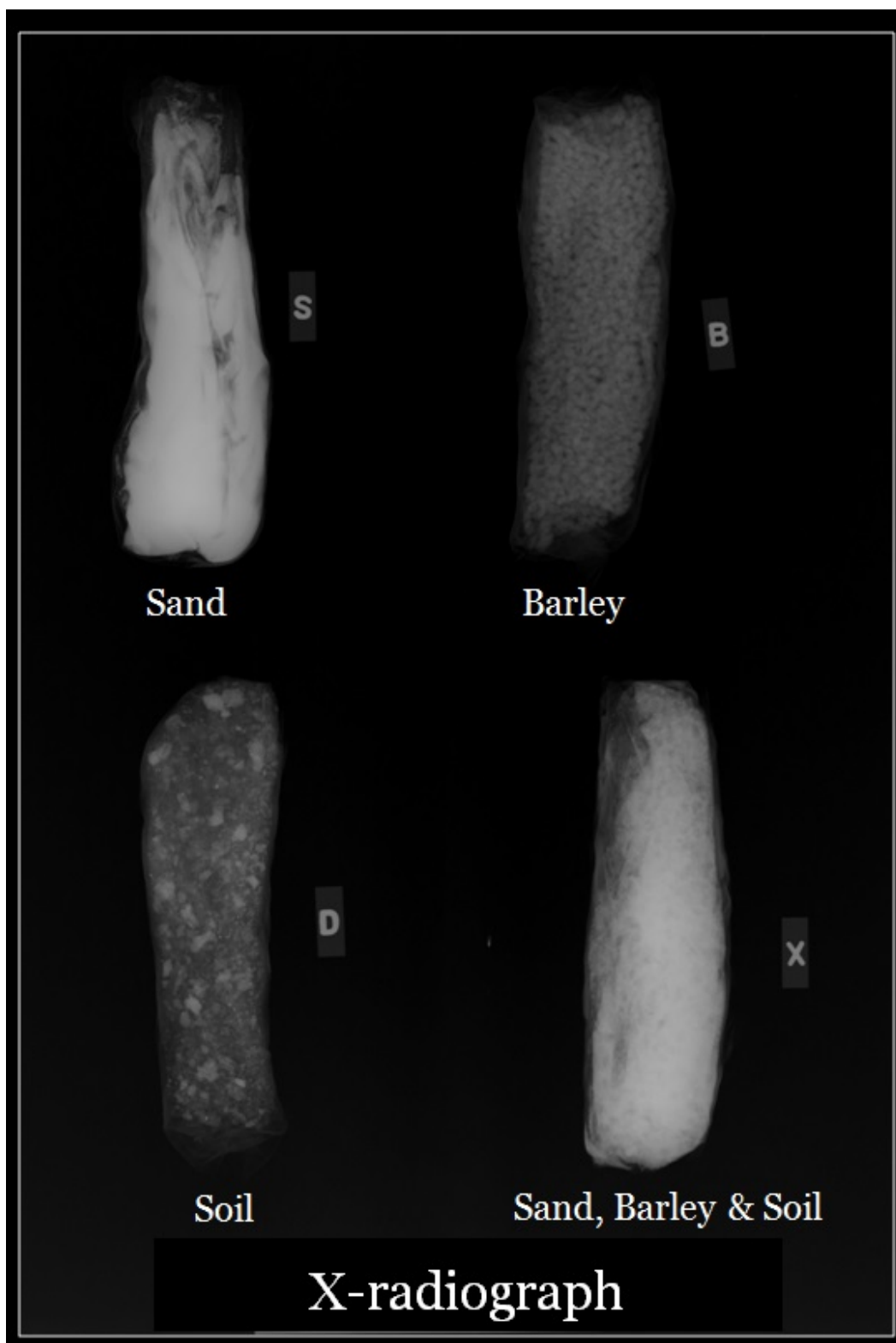


Figure 13- Osirid Dummy Mummy Replica



Figure 14- Osirid Dummy Mummy Replica, X-ray radiograph (35 kV, 5.0 mA, 30 s)

