

Summary

I. Introduction

The team from the Institute of Egyptology at Waseda University has been excavating at North Saqqara since 1991. The site is located on a prominent rocky outcrop in the desert approximately 1.5km to the northwest of the Serapeum (Figs.1-3). Excavations at the summit of the outcrop had revealed a monument of Khaemwaset, the fourth prince of Ramesses II and a mud-brick structure built by Amenhotep II and Thutmose IV respectively.

Since the tenth season in 2001, the excavations have focused on the slope of the outcrop. In the course of the excavations at the eastern slope, a previously unknown rock-cut chamber and a number of objects including a fragment of two statues of incumbent lion and statues of a lion goddess were exposed. Some of them bear the name of Khufu and Pepy I.

In 2002, during the eleventh season, the excavations on the southeastern slope revealed a massive layered stone structure probably built around the Third Dynasty and a shaft leading to two chambers to the east and the west respectively.

In 2003, during the twelfth season, the excavations were conducted around the layered stone structure, and we also opened a trench on the western slope of the outcrop to see if there are any archeological remains. In 2004, during the thirteenth season, we focused on the excavations at the area in front of the layered structure and the western slope of the outcrop. Prior to 2007, we had excavated the western slope of the outcrop in order to obtain more archaeological evidence originating from the summit of the outcrop. In 2008, we returned to excavate on the summit of the outcrop and discovered a New Kingdom tomb-chapel on a plateau approximately 40 m to the northeast of the monument of Khaemwaset. In February 2009, we discovered the burial chamber of the tomb chapel of Isisnofret near the northwestern corner of the New Kingdom tomb-chapel. In August in the same year, we found the funerary cache of the tomb of Isisnofret. Since the summer in 2009, our excavation has been suspended partly due to the Egyptian revolution in January 2011 when we just started excavations at North Saqqara. Since then, we had to wait for the permission to work at the site because of the security situation in Abusir-Saqqara area.

This report aims to summarize the work carried out in the Twenty-first season from September 3 until October 9, 2011 and the Twenty-second season of the Waseda University excavations at North Saqqara from August 25 until September 27, 2012 as well as the work conducted at the Magazine of the Saqqara Inspectorate from August 11 until September 27, 2012. The results of this work will be described in the following sections.

(Sakuji Yoshimura)

II. A Preliminary Report on the Twenty-Second Season of Waseda University Excavations at Northwest Saqqara

1. Introduction

In the past seasons in February and September 2009, we discovered the burial chamber of the tomb chapel of Isisnofret to the north-west of the New Kingdom tomb chapel and its funerary cache to the north of the tomb chapel. During the last season, we conducted a geophysical prospection by using GPR (Ground Penetrating Rader) in the area on and around the outcrop in our concession area in order to understand the distribution of the unexcavated archaeological remains to be investigated for the future.

2. The summit of the outcrop

The main goal in this season was to excavate these areas for better understanding the nature of the archaeological remains at this area in northwest Saqqara. We began excavating in the area designated as the grid number 8B and 10B to the southwest of the tomb chapel of Isisnforet (Figs.9, 10). After removing the surface layer of the sand, we uncovered the deteriorated limestone blocks in the location, which indicated anomaly by the GPR survey in the last season.

3. Southeastern slope of the outcrop

Then, we moved to the southeastern slope of the outcrop. In this area a clear division between the ground surface of the outcrop and the accumulation of sand was attested by the geophysical prospection in the last season. We set up the sounding trench measuring 10 m by 50 m and began removing the surface sand layer, which measures approximately 2m in depth in average (Fig.9, 11). In this trench, notably we found two pottery jars dating to the mid-Eighteenth Dynasty in situ. We also found the fragments of the Old Kingdom pottery shards. But the majority of the pottery shards date to the New Kingdom. Two shabti figures dating to the Late Period were found there (Fig.26, 1, 2). In the area of the anomaly by the GPR survey, we reached the very deep bottom of the valley of the bedrock, which is filled with relatively large crags. It was understood that the anomaly by the geophysical prospection was the reflection of the natural geographical features of the area instead of artificial remains in ancient times.

4. Southeastern Area

In the last season, GPR survey was carried in the area to the southeast of the outcrop where ground surface shows artificial depressions, which were also recognized by archaeological reconnaissance in the past seasons (Fig.9). The result by GPR survey revealed anomalies that appear to be the absence of the bedrock in the underground. There are at least two large depressions, which indicate the presence of shaft or some sort of human activities in the past.

We began excavating the northern depression area, which is called the Operation A (12.5m x 12.5m) (Figs.13, 14). In the center of this operation, we uncovered a shaft measuring 1m (east-west) by 1.2m (north-south) and 3.3m in depth, which we call the shaft A (Figs.13-15, 21). At the bottom of the shaft, it shapes like square, measuring 1.2m by 1.2m. It appears that the shaft A was unfinished, since the half of the bottom was roughly chiseled out in the depth of 25cm. On the southwestern wall of the shaft A from approximately 2m from its mouth, a chamber was cut into the rock to the direction of southwest. The chamber measures 1m in width and 3.6m in depth. We found a few fragments of the Late Period pottery shards in the shaft A, but there is no clear evidence of burial. However, remain of chiseling of a wall of the shaft facing to the entrance to the chamber shows enlargement probably due to the installment of coffin. It is possible that the chamber was used for burial and it was plundered later in antiquity.

The crags including large quartzite rocks surround the shaft A. Some of the large quartzite rocks shows the remains of wedge indicating quarrying activities. The largest quartzite rock appears to attach to the bedrock indicating the original geographical features of the terrain. Behind these crags, we identified at least two layers of tafl probably indicating the excavation activities of the bedrock in the shaft A in two times: the main shaft and the room to the southwest. Both to the south and north of the western side of the shaft, we uncovered black and gray layer of the sand, which contains ashes and charcoals with burnt quartzite chippings. Having observed these archaeological remains, it is assumed that the area was used as a sort of manufacturing place for quartzite in ancient times. But its purpose is not certain at this moment.

The Old Kingdom pottery shards just above the bedrock may indicate a terminus a quo and the Late Period pottery shards give a terminus ad quem for the duration of activity in the Operation A.

We also opened the Operation B approximately 28m to the south of the Operation A in this area (Figs.13, 17). The Operation B was another place indicating the presence of the shaft or some sort of excavation activities in the past. In this Operation, we uncovered 3 small pits (Figs.17-20, 22-24). The pit A is located to the western part of this operation,

which measures 96cm (east-west) by 54cm (north-south) and 42cm in depth. The pit A is cut in the middle of the flat bedrock surface, which was excavated in oval shape in the past. Around this flat bedrock surface, we found the rough stonewalls which were probably intended to prevent the collapse of the sand layers. The pits B and C are located in the eastern part of the Operation B. They also share the same features of the pit A hewn in the bed rock surface and surrounded by rough stone walls. The pit B measures 90cm by 90cm and 80cm in depth. The shape is almost like trapezoid. The pit B is cut in the middle of the depression hewn in the bedrock. Near the mouth of this depression, we found four fragments a lime stone plate incised with square pattern on both surfaces. In the sand layer accumulated in this depression, we found fragments of faience object, cartonage, and charcoal. However, there was no evidence of burial in this depression. The pit C is located near the southern wall of the Operation B. It was probably originally intended to cut in square shape, but excavated in rectangular shape measuring 120cm (north-south) by 66cm (east-west) and 140cm in depth.

These three pits do not appear to have intended to dig burial shaft, but their purpose is not certain. It is not unlikely that these pit relate to the activity observed in the Operation A. It is hoped that more evidence will come out in the future seasons in order to understand the nature of the site.

5. Major Finds

1) Pottery

The pottery vessel which date to the late Old Kingdom was discovered in-situ from the lowest layer of the southeastern slope of the outcrop (Fig.25.1). The parallels are known from late Old Kingdom site. This pottery vessel indicates some activities were conducted at the outcrop in the late Old Kingdom. In addition, the two pottery vessels were found in-situ at the upper layer of the southeastern slope (Fig.25.3, 4). They were discarded from the top of the outcrop. These pottery vessels are common in the mid-Eighteenth Dynasty. They were probably derived from the mud-brick structure belonging to Amenhotep II and Thutmose IV.

At the southeastern excavation area, the pottery shards so-called “beer jars” were found at the layer just above the bedrock (Fig.27.1, 2). Similar pottery shards are found from Dahshur that is dated to the early Old Kingdom. At the upper layer of the area, some pottery shards which date to the Late Period were uncovered (Fig.27.3). So far, the early Old Kingdom pottery shards provide a terminus a quo and the Late Period pottery shards give a terminus ad quem for the duration of activity in this area.

2) Fragments of Shabti figures

Two pieces of the faience shabti figures were found in the sand accumulation of the trench in the southeast slope of the outcrop (Fig.26.1, 2). Both of them are represented mummiform, with the arms clasped across the chest, each hand holding a mattock. A tripartite wig and false beard complete his costume. These dates from 27 to 28 Dynasties in the Late Period. Larger fragment, which remains from the head to the middle of the body, measures 6.1cm in Height and 2.7cm in Width with 1.6cm in Thickness. Smaller piece measures 3.4cm in Height and 2.4cm in Width with 1.6cm in Thickness.

3) Limestone board

Four fragments of a limestone game board were uncovered near the mouth of the depression. After assembling the fragments, it turned out a complete rectangular limestone board incised with square pattern on both surfaces, which measures 25.5cm in Length, 52.7cm in Width, and 5.0cm in Thickness (Fig.27.4). It is assumed that this limestone board was used for game on the basis of other parallels.

(Sakuji Yoshimura, Nozomu Kawai, Jiro Kondo, Hiroyuki Kashiwagi, Kazumitsu Takahashi, and Ayano Yamada)

III. Conservation Works

1. 2011 Season

The conservation project for Waseda University in Abusir South was carried out between September 13 and September 20, 2011. The original plan of this season was the conservation of the lime stone sarcophagus of Isisnofret in the tomb chamber. However, the post-revolutionary security situation in Egypt did not allow us to perform work on site. Thus, our main focus was shifted to the conservation of the sarcophagus fragments removed in 2009.

During the 2009 season, numerous small, inscribed fragments were brought to the magazine. Each fragment was assigned a registration number, recorded, cleaned and consolidated.

1) Sarcophagus of Isisnofret

This season, Dr. Kawai continued the reconstruction of the fragments based on their inscribed surfaces, without using adhesive. Egyptology students were tracing each inscribed fragment on a transparent sheet. These traced images will be scanned and used for further study and digital reconstruction during the off-season.

The limestone sarcophagus fragments were examined. In general, their condition has not changed since the 2009 season. No on-going active deterioration (such as salt spalling) was observed. The stone is relatively soft and slightly powdery; especially along break edges, as they were in 2009. Both black and blue pigments are stable. No flaking or fading was observed. Also, the ancient mortar remained stable.

As is mentioned above, many fragments were dry-joined on the sand box (i.e., some create quite large groups of 30 - 40 pieces.) The majority of the small pieces are thin and do not include the entire thickness of the sarcophagus walls. It is best to mend them to the main body of the sarcophagus rather than mending these surficial fragments together. If mended apart from the main body, there would be small accumulative deviations that could eventually cause misalignment. However, quite a few small fragments in danger of loss or misplacement were mended with acrylic resin after consolidating their break edges. This also facilitates Dr. Kawai's reconstruction work.

In addition to the above task, all break edges of the fragments were consolidated with diluted acrylic resin as preparation for mending when ready. This also protects the slightly powdery surfaces from handling.

Flakes detached from the limestone sarcophagus and mortar were tested by microchemical spot tests.

	chloride (Cl ⁻)	nitrate (NO ₃ ⁻)	sulfate (SO ₄ ²⁻)	carbonate (CO ₃ ²⁻)
debris of limestone substrate	+	slightly +	-	+
mortar fragment	slightly +	+	very +	+
mortar under black pigment	slightly +	-	-	+
mortar over black pigment	slightly +	+	-	+

It appears that the limestone contains chloride salt. However, no active damage has been observed on the fragments in the magazine since 2009. The ancient restoration mortar found under and over the pigment appears to be lime-based mortar while the mortar possibly used for sealing the lid may be gypsum mortar. These results will be confirmed by retesting during the off-season.

In the 2009 season, it remained undecided if the sarcophagus would be removed from the tomb chamber or not. However, with the political turmoil in winter 2011 as well as the post-revolution security situation may require secure storage for the sarcophagus. In either case, the sarcophagus needs to be moved to the center of the chamber in order to document and conserve the inscribed surface that is currently inaccessible. Although it might appear simple, the most challenging task is moving the sarcophagus from the current position to the center of the chamber. The space is tight,

the ceiling is low and unstable, and there is limited access to part of the coffin.

In order to protect the inscribed surface from abrasion caused by padding and straps, the surface may be faced with synthetic tissue.

A temporary consolidant called cyclododecane was tested for a possible facing material. Cyclododecane ($C_{12}H_{24}$) is a white, waxy cyclic alkane that is chemically stable and inert. It dissolves in nonpolar organic solvents such as hexanes and xylene and insoluble in water, acetone, and ethanol. It also melts at $60.7^{\circ}C$, and slowly sublimates at room temperature. Because of this nature, it does not require a solvent or cleaning for removal, and was thus used as a temporary consolidant.

Cyclododecane was tested on 3 fragments with pigment and mortar decoration. Japanese tissue, thin synthetic tissue and gauze (over tissue) were used as facing materials. Advantages of cyclododecane are its sublimation nature. This will be examined next season.

There are 2 cracks with gaps between the bottom and the south wall as well as the bottom and the north wall. These cracks penetrate through the thickness of the walls. There is also a fine crack on the west wall bridging between the above two cracks. It is not certain if this fine crack penetrates the thickness of the wall. It is possible the bottom has already been detached from the walls. Lifting the piece may separate these pieces.

Physical reinforcement

Several methods to reinforce the cracks (or breaks) described above were discussed. The cracks may be temporarily reinforced using carbon fiber fabric. A rigid, lightweight backing (such as an aluminum honey-comb sheet) may be used against the sarcophagus walls with a material that fills gap between the wall and the backing. Corners may be reinforced with L-shape brackets. In order to avoid collapsing the walls, the interior of the sarcophagus may be filled with wooden planks and polyethylene foam. A ratchet strap may be used to hold the sarcophagus as one unit. Some materials may not be locally available. Also, there may be a safety risks accompanying use of some chemicals with limited ventilation in the tomb chamber.

The all materials above are temporary and thus removed once the sarcophagus is moved.

Lifting

For lifting the sarcophagus, it is ideal to use a mechanical device such as a chain and a hoist on an I-beam frame. This allows vertical as well as horizontal transportation of the sarcophagus. However, there does not appear to be enough vertical space for the set-up of such a device. An alternative may be lifting from the underside. It is not clear how much access to the underside the sarcophagus. Lifting from the underside requires extra caution as uneven pressure at the bottom could provide stress to the already-cracked sarcophagus.

A rigid, lightweight pallet with low feet (a few centimeter) may be prepared to receive the sarcophagus immediately after lifting. The surface will be padded. Once it is on, the sarcophagus will always be handled with this pallet as a support.

It is difficult to finalize the method and materials without access to the actual object, as it has been 2 years since the last access to the sarcophagus. However, as is mentioned above, we can make preparation of the maximum protection for the sarcophagus.

2) Limestone blocks

Approximately 100 inscribed limestone blocks have been surveyed. Some blocks that exhibited active deterioration were treated. The condition of such blocks has been monitored since 2007.

A dozen of the inscribed limestone blocks that have previously been surveyed and treated were examined. The

conservation survey database was updated. The condition of the blocks has been unchanged. In spite of the uncontrolled environment in the storage, the blocks were found relatively stable. However, it appeared that some blocks were moved during the off-season, which caused chipping and abrasion. These blocks were re-secured with shims and padding.

SCA conservator, Mr. Ashraf Usef Ewais conserved a block with painted relief decoration (AK14-O382; kheker frieze). The surface was covered with granular burial accretions that was disfiguring. It was cleaned with ethanol and distilled water on a cotton swab.

3) Other tasks

Four fragments of limestone stelae previously excavated were examined upon request by Ms. Nishisaka. They were lightly cleaned. An examination report for each piece was entered in the database. Due to limited time available this season, further treatment was suspended, however, treatment recommendation was stated in the report.

Twelve copper alloy objects were examined. Based on the 2008 treatment carried out by Dr. Aoki, nine pieces with possible presence of bronze disease were treated using benzotriazole (BTA). Non-archival storage padding was replaced with polyethylene foam. Silica gel was placed in the box.

Upon request by Mr. Takahashi, a hard translucent crystalline material on a pottery shard was sampled for soluble salt analysis.

	chloride (Cl ⁻)	nitrate (NO ₃ ⁻)	sulfate (SO ₄ ²⁻)	carbonate (CO ₃ ²⁻)
crystalline material from vessel	very +	-	slightly -	-

Salt spalling of the decorated surface appears to be caused by chloride salts. Since desalination tried on 2 decorated fragments in 2008 are in stable condition, a routine desalination of important pieces are recommended prior to reconstruction. Mr. Takahashi carries out another desalination trial this season.

2. 2012 Season

The conservation project for Waseda University in Abusir South was carried out between August 25 and 30, 2012. The goal of the season was the conservation of the lime stone sarcophagus of Isisnofret in a tomb chamber discovered during the February 2009 season.

1) Introduction

In the end of the summer 2009 season, the tomb chamber of Isisnofret was closed with stone blocks and cement mortar as well as a locked metal door and a metal gate. The chamber had been inaccessible since then due to the 2011 revolution. This season, the chamber was opened for the examination, the conservation treatment, and possibly the move of the sarcophagus to the center of the chamber.

2) Condition

Tomb chamber

The tomb chamber remained relatively clean. The inscribed surfaces of the sarcophagus box, the fragments and the lid were covered with plastic sheets in 2009. This protected them from dust/dirt. However, pile of sand was found on the western rim and the interior bottom of the box. Sand appears to have fallen from wide crack(s) in the ceiling and possibly crack(s) in the west wall of the chamber. None of the plaster crack monitor installed across the cracks in 2009 were broken. New crack monitor called “telltai” may be installed this season which monitor movement of cracks in any two dimensional directions.

Environment

Temperature and relative humidity in the chamber seemed relatively stable. It had been monitored by datalogger. It was set to record about one year, and thus, it was not recording when the chamber was opened. A new datalogger was placed as soon as possible. Temperature in the chamber while working was between 26.2°C and 28.2°C with the average of 26.5°C. Humidity was between 72% and 88% with the average of 85.4%.

Sarcophagus of Isisnofret

No new damage was observed on the limestone sarcophagus box, the lid and the fragments. Japanese tissue facing placed along the cracks in the west, south and north walls during the 2009 season was found moist. The tissue in the northwest corner exhibited greenish-yellow mold-like material. In 2009, this area appeared to have been most affected by presence of soluble salts. This might indicate that the area was exposed specifically high humidity or contains hygroscopic material such as soluble salts.

Cracks in the west, north and south walls appeared unchanged. The underside of the box was wedged with limestone and wooden pieces to prevent the bottom from dropping and detaching at the cracks.

Pigments

Black and blue pigments in the inscription were generally intact. However, the pigments on the west and the south walls of the sarcophagus box that were not treated in the 2009 season due limited accessibility were friable and flaking in some areas. Debris of the blue pigment was found on the floor along the south wall. It must have been fallen since the 2009 season, possibly caused by soluble salts, vibration, etc.

3) Treatment

Prior to treatment, the object was digitally documented. The friable black and blue pigments on the south and west walls of the sarcophagus were stabilized. Ideally, they should be treated with better access and after thorough documentation. However, since the pigments were actively detaching, emergency stabilization was necessary.

The pigments were consolidated as much as accessed using 2.5% Paraloid B-72 in acetone. Diluted primal was previously used because of limited ventilation in the chamber and its minimal darkening of the pigments. This time, acrylic resin was selected since there is a possibility of mold-growth (as in the case on the Japanese tissue facing). Also, an aqueous solution, such as Primal, with high surface tension, could not be easily absorbed into the pigment layer(s). Since the access is limited and often the consolidant has to be applied from upper sections, it could be run over on the vertical surface and push/move and dislodge pigment particles. The consolidant was applied by a brush or a syringe. A mirror was used to view the area to be treated.

4) Moving sarcophagus

A plan for this season was reviewed with Dr. Kawai, Dr. Kashiwagi and Mr. Takahashi and myself. Originally, Dr. Kawai planned to move the sarcophagus box to the center of the chamber for documentation and conservation. However, discovering the debris of the pigments on the south and west walls shifted this plan. It was crucial to stabilize the pigments before moving the box. Additionally, the following issues need to be addressed before moving;

- Cracks in the central area of the ceiling in the tomb chamber should be examined and stabilized if necessary prior to moving the box below the cracks. This should be consulted with engineer or geologist
- moving method and equipment should be carefully planned and prepared.
- Determination of the final location of the sarcophagus to avoid moving it multiple times.

Currently, we plan to keep the sarcophagus in-situ as it is safer for the object and ideal for the future display in the original location.

Lid

Although we are planning to keep the sarcophagus in-situ, we decided to remove the lid temporarily to the magazine for further study and documentation. Also, this will provide proper workspace for documentation and conservation of the box.

Preparation for lifting lid

The lid was prepared for transportation. The pigment was lightly cleaned and consolidated by a SCA conservator, Ismail Ragab Abdallah. Break edges were temporarily protected by cyclododecane. A pallet with caster designed by Dr. Kashiwagi was built for each fragment to facilitate to move the fragment for study and documentation.

Lifting procedure

Ideal procedure was discussed with Mr. Takahashi who supervised the workmen when moved. The following steps were recommended for lifting each fragment was made;

- One staff member stays in the chamber to supervise handling of the fragment to be lifted while another member stays outside to supervise handling of the raised fragment.
- A rigid box may be prepared for each fragment, possibly with collapsible hinged-side walls for safe access.
- The worked surface and edges of the fragment should be protected with smooth foam (close-cell polyethylene foam.) Unworked surface may be protected with local sponge with a smooth polyethylene sheet as an isolating layer.
- The entire fragment and foam and/or sponge is tied with a flat belt or a ratchet strap.
- The padded fragment is placed in the box. Excess space in the box should be filled with sponge to secure the fragment.
- The box, kept as level as possible, is rolled or pulled upward in the corridor.
- The box, again kept level, is raised by a pulley consisting of a chain and a hoist.
- The transportation of the fragments should be supervised by staff. Vibration should be kept minimum.
- Once in the magazine, each fragment is unwrapped and placed on a pallet with casters. The pallet should be padded with close-cell foam. Each fragment should be cover with a polyethylene sheet. This process should be supervised.

5) Future plan

The following tasks remained for future season(s).

Structural stabilization of the chamber

Structural stability of the tomb chamber, especially the cracks in the ceiling and the walls, need to be reviewed and discussed with a geological engineer, a structural engineer and/or a geologist. Possible scenarios are;

- The cracks are non-structural and stable, thus, only cosmetic work is required (i.e., mortar filling).
- The cracks are unstable, and thus, require chemical reinforcement such as epoxy resin injection.

- The cracks are unstable, and thus, requires physical reinforcement such as jack post.

Moving the sarcophagus box

Ideally, the sarcophagus box is moved to the center of the chamber in order to thoroughly document and conserve the inscribed south and west walls. As is described above, the cracks in the central ceiling need to be stabilized prior to moving.

Preparation of moving the box

The main challenge of moving the sarcophagus box is its fragile condition and the location. The box is physically fragile. Also, it is placed in a recessed floor which prevents the box from easily pulling/pushing to the center. It is ideal that a trained mason supervise to move the box.

There are 2 cracks with gaps on the lower south and north walls. There is also a fine crack on the west wall bridging the two above cracks. It is possible these are actually a break rather than cracks, and thus, the bottom portion is already detached. If still intact, moving the box may cause break. In order to avoid breaking;

- Prior to moving, the cracks may be temporarily reinforced using materials such as carbon fiber fabric, a rigid, lightweight backing, bracing the walls, brackets at the corners, etc. The reinforced box with proper padding may be strapped with ratchet straps to hold the box as one unit.
- Prior to moving, the cracks may be permanently joined. Sandy debris in the cracks should be fully cleaned. An epoxy resin may be injected and the bottom may be carefully raised to close the cracks. At this time, the alignment of the joins should be perfect since it will affect joins of the rest fragments of the box.

Moving procedure and equipment

For lifting the sarcophagus, it is ideal to use a mechanical device such as a pulley consisting of a chain and a hoist on a metal frame. This allows smooth vertical as well as horizontal transportation of the sarcophagus in the chamber. However, the ceiling in the chamber seems too low to set-up of such a device. An alternative, more realistic method may be lifting the box from the underside. It is not clear how much access to the underside the sarcophagus. The area under the box appears to be filled with sand and limestone chips. It does not seem to have enough space to use regular hydro-jack(s). Lifting from the underside requires extra caution as uneven pressure at the bottom could provide stress to the already-cracked sarcophagus.

Treatment of the box

Once the sarcophagus box is moved to the center of the chamber, the following tasks are performed.

- Full documentation of the west and south walls.
- Conservation of the box including stabilization and reconstruction.

Site management

It is not too early to plan the presentation of the site including flooring, railing, signage, etc. This reduces handling and risking the object. If the chamber will eventually be opened to public, the space should be well-designed. The sarcophagus should be protected from the visitors, and at the same time, visually accessible.

Install the sarcophagus in the original location:

pros:

- The south and west walls with well-preserved inscription will be inaccessible. This may be compensated by displaying photographs/drawings.
- Keeping the object in the original location is ideal.

cons:

- This gives enough space for placing the lid on the box.
- This also provides enough space to keep them out of visitors' reach.

Install the sarcophagus in the center of the chamber:

pros:

- All inscribed sides are accessible.

cons:

- Too tight to place the lid on the box.
- The object will be within visitors' reach.

It is important to prioritize our goal that may partially determine the design (protection vs. accessibility).

6) Conclusion

It was difficult to previously plan work for this season because it was inaccessible for past 2.5 year. Despite limited time, conservation work carried out this season was crucial to prevent the object from further deterioration, and also, to prepare for the upcoming season. It was extremely beneficial to examine the condition of the sarcophagus in-situ. This will enable us to continue our research during the off-season and prepare for the handling and removal of the sarcophagus.

(Hiroko Kariya)

IV. Anthropological Study

In this season, two sets of the human skeletal remains from the site of Northwest Saqqara were examined. Namely, the remains found at the burial chamber of the tomb chapel of Isisnofret in 2009 and the remains found at the intact multiple burial in 2003.

1. Skeletal remains from the tomb chapel of Isisnofret

The preliminary study of the remains was carried out in 2009. In this season, an additional study has been done especially on the pathological diagnosis using X-ray photography by the kind help of Prof. Salima Ikram of the American University in Cairo.

1) Number 1 skeleton (Figs.43, 44)

Almost all of the bones were preserved (Figs.43, 44). This individual is an infant and its estimated age-at-death is 10±2.5 years old by its dental development and length of the limb bones. The sex of this individual is not known because of its youth.

Attribution for known populations of this individual is probably Europeans in a wide sense on the basis of its high orbits, anteriorly-projected nasal bones, and a receded dental arch and cheek bones. It has very large upper central incisors as Europeans. The morphology of the skull resembles that of Number 2 individual.

The cribriform plate of the ethmoid bone was perforated for excerebration, and the black paintings similar to “eyebrows” were drawn on the supraorbital margins (Fig.43).

Several thoracic vertebral bodies are wedge-shaped (Th4, Th6 - Th8), which may be caused by the Scheuermann’s disease or congenital kyphosis (Fig.45). Dental caries are seen in the right upper first deciduous molar and the right and left upper second deciduous molars. Pathological changes are seen around the socket for first and second deciduous molars of the left maxilla.

2) Number 2 skeleton (Figs.46, 47)

Most of the bones were preserved (Figs.46, 47). This individual is an adult female. The sex was diagnosed as female from the width of the greater sciatic notch and the flatness of the eyebrow region. The age-at-death was estimate as 30-45 years old, from the morphology of the pubic symphysis (Suchey-Brooks method). Her stature was estimated as 162.7cm from the lengths of the limb bones. Although the skull of this individual shows many characters commonly recognized in the European (Caucasians), as are seen in the Number 1 Individual, it has a unique mosaic of morphological features from various living human populations, such as large upper central incisors, long distal limb bones, etc.

On the one hand, the FORDISC 3.0 with 12 craniometrical measurements variables classified this individual into the “Egyptian female” group out of 28 reference populations. On the other hand, this individual was classified into the Afro-American, using a discriminant function of 15 measurements in postcranial skeletons calculated with the Euro-American (N=50, Terry collection and Hamann-Todd collection), Afro-American (N=50, Terry collection and Hamann-Todd collection), and Japanese (N=43, the University of Tokyo, Kyoto university, Chiba University, and Kyusyu University) (Fig.50).

An abnormal periosteal bone formation and a diaphyseal swelling are seen in the right tibia, which was presumably caused with osteomyelitis (Fig.48). New bone formation and discontinuity in the proximal articular facet of the proximal phalanx of right thumb were suspected to be the healed avulsion fracture caused by extensive tensile force of the flexor pollicis brevis muscle (Fig.49). As in the Number 1 skeleton, the perforation of the ethmoid bone and eyebrow-like paintings are seen (Fig.46).

3) Number 3 skeleton (Figs.51, 52)

Only about a half of the whole bones were preserved. This individual may be a young-adult female (15-25 years old), which was diagnosed from the morphologies of the greater sciatic notch and pubic symphysis. Her stature was estimated as 163.6cm. She has low and wide orbits, a wide forehead, a stout coronoid process of the mandible, which are quite different from those seen in Number 1 and 2 skeletons. In addition, she has an extremely long forearm bone (ulna), and was classified into Afro-American by the abovementioned discriminant function of postcranial measurements (Fig.50).

There is a circular bone resorption at the posterior surface of distal metadiaphysis of the left femur, which can be diagnosed as fibrous cortical defect.

4) Number 4 skeleton (Fig.55)

About 1/3 of the whole bones were preserved. This individual may be a young-adult male (15-25 years old), according to its morphologies of the greater sciatic notch and pubic symphysis. His estimated stature is very high, 183.4cm. Generally, the morphologies of the bones resemble well those of Number 2 skeleton. With a discriminant function of 15 measurements calculated from Euro-American male (N=50), Afro-American (N=50), and Japanese (N=50), this individual is classified into Euro-American (Fig.61).

Degenerative change and osteophytes are seen at the auricular surface of the right innominate bone and cuboidal

articular margin of the left calcaneus (Figs.58, 59). The occurrence of these bone changes around articulation in spite of his young age indicates that this individual was put under physically harsh conditions.

Periosteal bone formations are seen in the right and left tibiae. There is no expansion or constriction in the medullary cavities and no cloaca on the X-ray film (Fig.57). Therefore, this disorder was diagnosed as periostitis. A large circular bone resorption is seen at the right ilium (Fig.56). This pathological change may be caused by osteocystoma or osteosarcoma, because it is a singular resorption and not accompanied by bone formation on the X-ray film.

5) Identification of the individual of Isisnofret.

The Number 4 individual is a male, which means that he should not be Isisnofret. As is known, the face of the King Ramesses II shows typical European features. The Number 1 and 2 individuals show European features, while the Number 3 individual shows African features. Thus, the Number 3 individual might not be Isisnofret.

The Number 1 and Number 2 individuals might be in blood relationship (mother and child) because their mummifications were carried out under the same style (the drawn eyebrows in black and the perforation of the ethmoid bone), their faces resemble well with each other, and their upper central incisors are extremely large as Europeans.

If the Number 1 individual is Isisnofret, Number 2 individual might be his/her mother and the wife of Khaemwaset, the son of the King Ramesses II. This means that the tomb chapel was supposed to be for the wife of Khaemwaset, which contradicts the hieroglyphic evidence of the tomb chapel. Thus, the No. 2 middle aged woman might be Isisnofret herself.

2. Skeletons from the intact multiple burial

Preliminary identifications were carried out. Tentative results on the contents of human remains are listed below.

1) Human remains outside the coffin

Number 705: Adult male (30-40 years old)

Number 763: Adult female (20-40 years old)

No number: infant

2) Human remains inside the coffin

Number 802: Child (4±1 years old)

Number 803: Child (6±2 years old)

Number 804: Probably male child (10±2 years old)

Number 805: Child (9±3 years old)

Number 806: Child (7±2years old)

Number 807: Young male (15-19 years old)

Number 808: Adult male (35-50 years old)

Number 809: Adult female (35-50 years old)

No number: infant

(Kazuhiro Sakaue and Hisao Baba)

V. X-ray Analysis of the Objects

1. Characterization of several colorants used for the New Kingdom Egyptian glass and faience

The results of chemical identification of the colorants used for the New Kingdom Egyptian glasses and faiences were summarized in Tables 1 and 2 based on our nondestructive analyses of excavated objects from Northwest Saqqara and Dahshur North. Possible sources of each colorant were also listed in these tables.

Following our previous researches, we continued to focus on the cobalt-blue glass and faience belonging to the Ramesside Period (the 19th-20th Dynasties), New Kingdom of Egypt. As shown in our previous analyses, the cobalt-blue colorant used in these Ramesside objects was different from the colorant derived from cobaltiferous alum used in the 18th Dynasty, based on the comparison of transition metal composition and alumina content with those of the cobalt blue-colored artifacts from the 18th Dynasty. This result suggests that a new cobalt source other than cobaltiferous alum from the Western Oases was utilized in Egypt during the Ramesside Period. On the other hand, we newly found that variation of the manganese content in the Ramesside cobalt-blue colorant was much wider than that estimated by our previous analyses.

Similar to the study of the cobalt-blue colorant described above, we continued to focus on the ancient Egyptian yellow glasses and faiences colored by the addition of synthesized yellow pigment, namely “lead antimonate ($\text{Pb}_2\text{Sb}_2\text{O}_7$)”. On the basis of the comparison of the contents of some elements that could be derived from the impurities of lead source, both compositional similarities and differences between the Ramesside yellow faience excavated from Northwest Saqqara and Dahshur North were revealed. As pointed out in our previous study, Ramesside yellow glasses excavated from Dahshur North had the characteristics of the lack of zinc, in spite of zinc-rich composition of typical New Kingdom yellow glasses. The inclusion of zinc in the New Kingdom yellow glasses and faiences must be derived from the utilization of zinc-rich galena (lead sulfide: PbS) from Egyptian Eastern coast, e.g. Gebel Zeit. We newly found that yellow glass objects belonging to the 18th Dynasty from Dahshur North also have a zinc-poor composition similar to the Ramesside objects. These results suggest the presence of the glass workshop(s) using zinc-poor lead ore as the raw material of yellow glass during the New Kingdom Period.

Table 1 Colorants used for the New Kingdom glasses and their possible sources

Color	18th Dynasty	Ramesside Period
Deep blue	Cobalt (Alums from Western Oases)	Cobalt (Unknown cobalt source)
Opaque yellow	Lead antimonate: $\text{Pb}_2\text{Sb}_2\text{O}_7$ (Galena from Eastern coast)	Lead antimonate: $\text{Pb}_2\text{Sb}_2\text{O}_7$ (Unknown lead source)
Pale blue	Copper (Scraps of bronze objects)	Copper (Scraps of bronze objects)
Opaque red	Copper (Scraps of bronze objects)	Copper (Scraps of bronze objects)

Table 2 Colorants used for the New Kingdom faiences and their possible sources

Color	18th Dynasty	Ramesside Period
Deep blue	Cobalt (Alums from Western Oases)	Cobalt (Unknown cobalt source)
Yellow	Lead antimonate: $\text{Pb}_2\text{Sb}_2\text{O}_7$ (Galena from Eastern coast)	Lead antimonate: $\text{Pb}_2\text{Sb}_2\text{O}_7$ (Galena from Eastern coast)
Pale blue	Copper (Scraps of bronze objects)	Copper (Scraps of bronze objects)
Red	Iron oxide: Fe_2O_3 (Unknown iron source)	Iron oxide: Fe_2O_3 (Unknown iron source)

2. Re-analyses of ancient Egyptian faïences

Because we brought newly developed X-ray fluorescence spectrometer to the site in this season, we re-analyzed several faïence objects previously analyzed by older instrument to obtain more detailed compositional information. Introduction of the vacuum chamber make it possible to discuss the alkaline component of faïence. In addition, because of higher energy resolution of the newly developed instruments, we could achieve more accurate quantification of trace elements contained within the ancient Egyptian faïence.

3. Compositional analyses of “Egyptian Blue”

In this season, X-ray fluorescence analysis was newly focused on Egyptian Blue, one of the most major pigments used in the ancient Egypt. We analyzed several Egyptian Blue objects for different purposes, e.g. ornament, inlay, and pigment, belonging to the 18th Dynasty and Ramesside Period. It was found that most of the Egyptian Blue objects contain a significant amount of tin; thus, scraps and rusts of bronze would be used as the copper source in the production of Egyptian Blue, as pointed out in other copper-colored objects in New Kingdom of Egypt.

Comparison of trace element contents (e.g. arsenic as impurity of copper-blue colorant) of the Egyptian Blue objects suggested the possibility of a compositional transition during the New Kingdom Period as shown in Fig.63. In addition, we found that trace element composition of Egyptian Blue objects can be comparable to those of copper-blue faïences and glasses produced in the New Kingdom of Egypt. Whereas the New Kingdom Egyptian copper-blue glasses tend to contain high amount of arsenic as impurity of copper-blue colorant, copper-blue faïence produced in the New Kingdom of Egypt show lower arsenic amount. It is possibly that these two tendencies of arsenic content shown in the New Kingdom Egyptian copper-blue glass and faïence could relate to compositional transition in Egyptian Blue objects as discussed above.

4. Influence of surface weathering of glass

Because we used a nondestructive analysis technique in this study, the results of the analyses may have been affected by surface weathering of the artifacts. To estimate the degree of surface weathering of the glass artifacts excavated from Dahshur North, we analyzed three kinds of Ramesside glass objects (deep blue, turquoise blue and yellow) with freshly broken sections. As shown in Fig.64, our analytical results of these glasses clearly showed that heavy elements used for our compositional characterization are much stable against the surface weathering, although light elements (especially alkaline component) could be affected by the weathering.

(Yoshinari Abe, Kanae Toyama, Ayana Nakamura, Aya Okoshi and Izumi Nakai)

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