Ancient Asia

Archaeological and Anthropological Investigation in Case of Urgent Time Constraints of Rescue Archaeology in South Korea

SHORT REPORT

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ABSTRACT

In the general context of rescue archaeology or in any emergency salvage operation, especially where human bones are involved that need to be cremated within a short time frame, anthropologists cannot conduct their work carefully at a university or institute lab. Thus, they have sought ever-more efficient and effective investigative protocols by which work can be conducted in cases of urgent time constraints. A recent anthropological survey conducted at a small town in South Korea (Goryeung) is thus significant. A joint team of anthropologists and dress historians performed collaborative research work in a "field lab" set up at the excavation site. Our novel protocol, by which academic data demonstrably can be successfully secured in the field instead of having to be sent to a university or institute lab, could be useful for the purposes of rescue archaeology.

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INTRODUCTION

The study of ancient graves in South Korea sometimes involves technical difficulties. Descendants of mummified or skeletonized subjects found therein often object to academic investigation of their ancestor's body, in which cases, the body often is required to be cremated on the same day of discovery (Kim et al 2020). This situation — the necessity for immediate, on-the-spot analysis, which is to say, rescue archaeology — tends to put investigators under acute and difficult time constraints as they make observations and perform analyses.

In response, anthropologists in South Korea have sought ever-more efficient and effective investigative protocols. A recent rescue archaeology case conducted in a small town in South Korea is significant in that regard. During the investigation, a joint research team of anthropologists and dress historians performed collaborative work in a "field lab" secured at the excavation site. The investigation was carried out very successfully, both parties having been able to achieve satisfactory research outcomes under the difficult conditions prevailing. In the expectation that this trial is not a one-off but could be re-applied in similar future cases of rescue archaeology, the research process followed is introduced in detail herewith.

ARCHAEOLOGICAL INFORMATION

More than 160 graves and residence ruins (habitation sites) have been unearthed in Goryeung County, Gyeongsangbuk-Do province (***Figure 1***). In 2019 and 2020, an archaeological survey

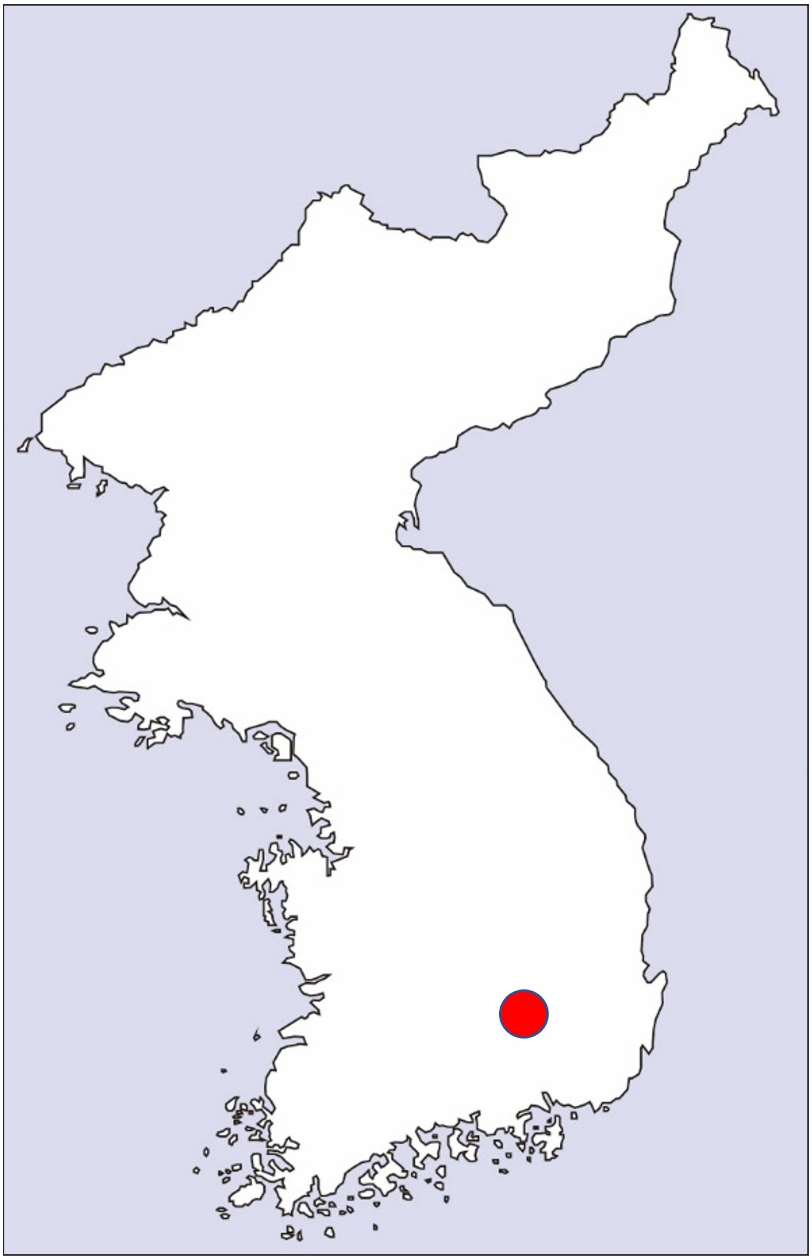

Figure 1 The location of Goryeung county (Gyeongbuk province), South Korea.

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was conducted on some of them by Gaon Research Institute of Cultural Properties (Goryeung, South Korea). The archaeological investigation was conducted in compliance with Korea's Act on the Protection and Investigation of Buried Cultural Properties in Advance of Construction.

Among the graves, intensive research was required for burial #9 dating to the Joseon Dynasty period (1392–1910 CE) (***Figure 2A***), considering the excellent preservation status of the coffin (***Figure 2B***) and clothing found therein (***Figure 2C***). In opening burial #9, archaeologists found a piece of fabric lying on the coffin (***Figures 2A*** and ***3A*** to ***3C***). The fabric bore an inscription on the individual's identity: a widow named Gwak, a freedwoman who had been emancipated from slavery (***Figure 3A*** to ***3C***).

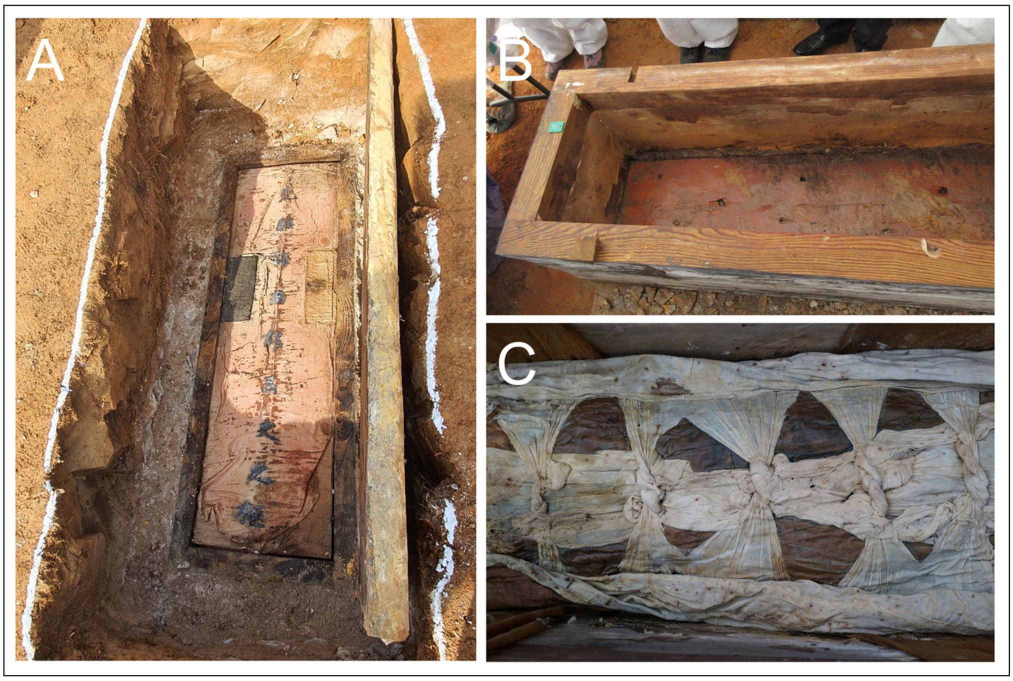

Figure 2 **(A)** The excavation site at Goryeung county. **(B)** Excellent preservation condition of coffin. **(C)** A mummy bundle including dead body and clothing.

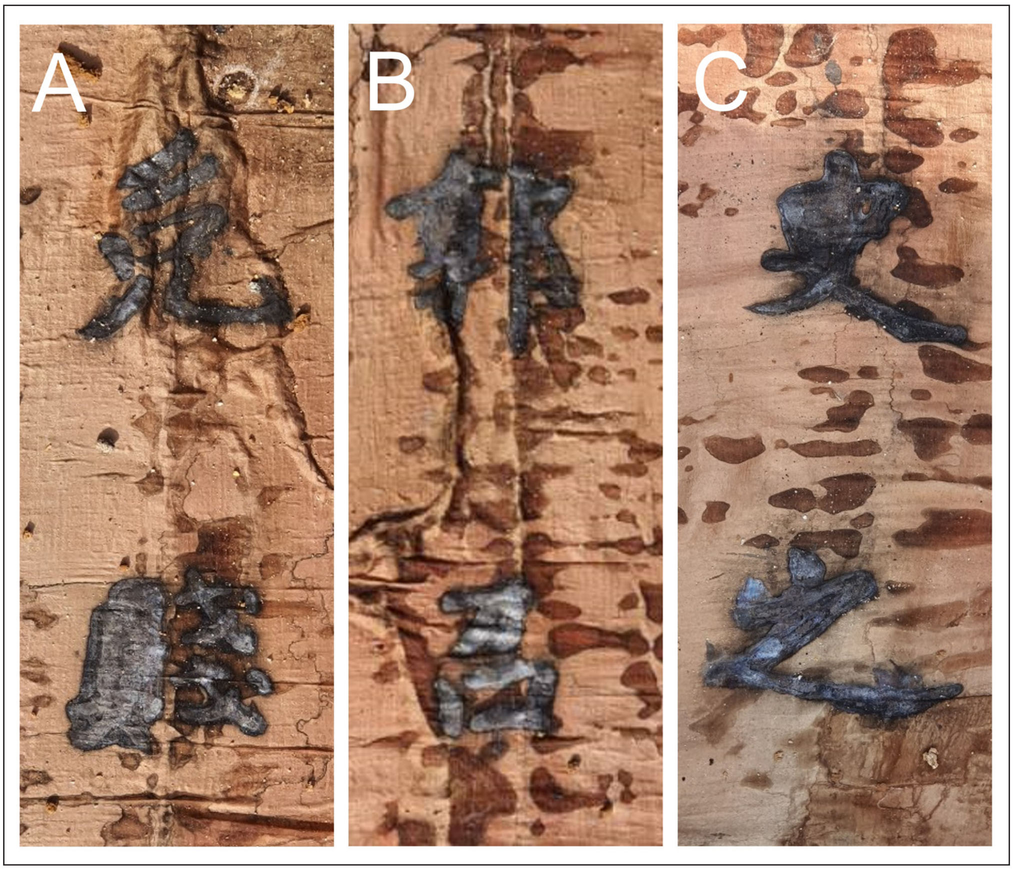

Figure 3 Goryeung county grave. **(A)** A fabric lying on the coffin **(B)** to **(C)** Magnified images of letters on the fabric. **(A)** means 'a freedman emancipated from a slavery'. **(B)** and **(C)** mean that the dead individual was named Gwak.

FIELD LAB

At this stage, the archaeologists invited anthropologists and dress historians to join the investigation of burial #9. Due to the looming completion deadline, they could not carry out their research in a well-equipped university or institute lab but rather, were obligated to complete their investigation on the spot. To streamline and expedite the investigative process, the archaeologists set up a field lab beside the grave (***Figure 4A***). In the lab, to minimize contamination during the investigation, the anthropologists and dress historians wore sterilized gowns, head caps, masks, and gloves. The dress historians then hurriedly but effectively removed the clothes that had enshrouded the body (***Figure 4B***).

Figure 4 (A) Makeshift field lab. **(B)** Researchers carried out academic work while wearing sterilized gowns, head caps, masks, and gloves.

ON-THE-SPOT ANTHROPOLOGICAL INVESTIGATION

Once all of the clothes were removed, the anthropological examination began immediately (***Figure 5A***). The investigators found that the individual's soft tissue had mostly disappeared, but that the skeleton remained structurally perfect (***Figure 5B***). They completed their examination in the field lab as soon as possible and were thus able to expedite their return of the skeleton to the archaeologists (excepting hairs that they had retained for further stable isotope analysis).

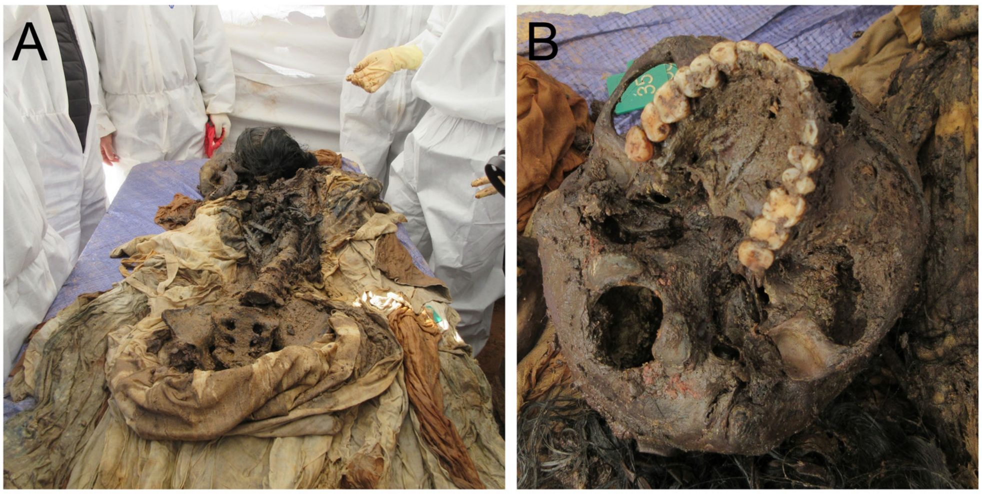

Figure 5 (A) Anthropological examination at field lab. **(B)** Skeletons remained perfect.

The anthropologists analyzed the bones using the standard anthropological techniques of Buikstra and Ubelaker (1994). The sex was estimated as female by examination of the pelvis. This determination supported the archaeological finding of "female" that had been based on the coffin fabric's inscription. The individual, judging from the deep-groove traces in the preauricular sulcus of the pelvic bone, was presumed to have given birth at least once (Walker 2005). The individual's age was estimated by tooth attrition and the degree of mechanical changes remnant in the long bones. The tooth attrition stage was H (40–50 years of age) by

Lovejoy et al's method (1985). The entheseal change found in the clavicle, humerus, ulna and femur along with the degenerative changes (marginal osteophyte) in the spinal column supported the estimation by teeth attrition (Igarashi et al 2020). Her stature was approximately 162.9 cm, as determined by the formula for Asian populations implemented in Trotter and Gleser's method (1958). An inventory of bones is summarized in ***Table 1***.

	L	R		L	R
Cranium					
Frontal	1		Maxilla	1	1
Parietal	1	1	Nasal	1	1
Occipital	1		Ethmoid	1	1
Temporal	1	1	Lacrimal	1	1
Zygomatic	1	1	Vomer	1	1
Palate	1	1	Sphenoid	1	1
Mandible	1	1			
Body	1	1	Ramus	1	1
Dentition					
Max. I1	1	1	Mand. I1	1	1
Max. I2	1	1	Mand. I2	1	1
Max. C	1	1	Mand. C	1	1
Max. P1	1	1	Mand. P1	1	1
Max. P2	1	1	Mand. P2	1	1
Max. M1	1	1	Mand. M1	1	1
Max. M2	1	1	Mand. M2	1	1
Max. M3	1	1	Mand. M3	6	6
Postcranium					
Hyoid	3		Thoracic 1–12	1	
Clavicle	1	1	Lumbar 1–5	1	
Scapula	1	1	Sacrum	1	
Humerus	1	1	Ilium	1	1
Radius	1	1	Pubis	1	1
Ulna	1	1	Ischium	1	
Hand	1	1	Femur	1	1
Manubrium	1		Patella	1	1
Sternal Body	1		Tibia	1	1
Ribs	1		Fibula	1	1
Atlas	1		Calcaneus	1	1
Axis	1		Talus	1	1
Cervical 3–7	1		Foot	1	1

Table 1 Inventory of Goryeung Skeletons.

INVENTORY: Codes: 1 - present complete 2 - present fragmentary 3 - absent (postmortem) 4– antemortem loss 5 - unerupted (dentition) 6 – congenitally missing.

Pathological findings also were examined, based on which, we could see no signs of trauma. No signs of dental caries were in evidence either, but periodontitis was seen in the 2nd molar (right) of the upper jaw. Dental calculi were observed in both upper and lower jaw teeth (nos. 13~17, 21~24, 26~28, 31~47), but only in the upper (supragingival) margin. Our finding of cribra orbitalia (CO) in the left orbital roof indicated that this individual might have suffered from iron-deficiency anemia, malnutrition, infectious diseases, and/or parasitism, among still-other possible maladies (Rivera and Lahr 2017). Linear enamel hypoplasia (LEH), a dental stress marker caused by physiological stress in early life (Goodman et al 1991; May et al 1993; Zhou and Corruccini 1998; Lukacs 1999; Lukacs et al 2001; Guatelli-Steinberg and Benderlioglu 2006), was seen on the crown surfaces of the upper incisors. In this case though, the LEH grade was not severe (medium: between 1 to 2). We also found cranial non-metric traits such as occipital ossicles, parietal foramen (both sides) and a third trochanter as a post-cranial nonmetric trait (Buikstra and Ubelaker 1994). In summary, this female had been an adult manifesting degenerative change in the teeth and vertebrae.

CLOTHING

After our investigation was completed, the anthropologists and dress historians withdrew from the excavation site with clothes and very small amounts of human samples collected from the Joseon-period grave. Dress historians moved their clothes to their lab at Seoul Women's University for the purposes of repair and in-depth research. (***Figure 6*** and ***Table 2***).

Figure 6 Jangot (long coat for women) collected from Goryeung grave.

STABLE ISOTOPE ANALYSIS

Hair samples were prepared for stable isotope analysis as follows. Notably, the entire research process was undertaken on a clean bench. Samples were washed by distilled water and dehydrated in ethanol. The stable isotope analysis was performed in Beta Analytic (Florida, USA)'s Kit. The samples were subjected to Isotope Ratio Mass Spectrometry (IRMS). They were dispensed from an Elemental Analyzer (EA) in a helium stream with coincident O_2 injection using ISODAT software (Thermo Scientific, Massachusetts, USA). Separation and detection of CO_2 masses was via gas chromatography (GC). Correction for drift was applied by normalizing the in-house standard to the expected value. After the samples were weighed on a Cubis microbalance (Sartorius, Göttingen, Germany), they were transferred to a small tin boat for C: N analysis. The tin boat was then loaded into a 4010 Elemental Analyzer (Costech Analytical, California, USA) and combusted in a furnace (1,000°C), the gases being separated by GC column. ECS Clarity software (Isomass Scientific Inc., Alberta, Canada) was used for determination of the %Nitrogen, %Carbon and C: N ratio.

Experiments were repeated twice to obtain a mean value, which was further compared with the hair isotope results of earlier archaeological reports from Peru (Pacatnamu), Alaska (Nunalleq) and Japan (Osaka) (White et al 2009; Britton et al 2013; Maruyama et al 2018) (also summarized in ***Table 3***). Pacatnamu is an archaeological site located on the North Coast

SERIAL NO.	ID	MATERIAL	FEATURES
1	Long cloth	Cotton	
2	Paper	Paper	Covered from head to toe
3	Jeogori (Jacket)	Cotton	
4	Jangot (Long coat for women)	Cotton	Lapis lazuli colored
5	Paper	Paper	
6	Fabric	Cotton	Found near left hand
7	Ibul (Daeryumgeum; Outer Comforter)	Cotton	Covering a corpse
8	Fabric	Cotton	Found near right hand
9	Chima (Skirt)	Cotton	Over the waist
10	Chima (Skirt)	Cotton	Placed under skirt #9
11	Baji (Trousers)	Cotton	
12	Ropes (Tying Longitudinally)	Silk	
13	Fabric	Cotton	
14	Ropes (Tying Transversely)	Silk	
15	Baji (Trousers)	ND	Left side of the body
16	Chima (Skirt)	Cotton	Right side of the body
17	One piece of Beoseon (Socks)	Cotton	Near the left foot
18	One piece of Beoseon (Socks)	Cotton	Near the right foot
19	Fabric	Silk	
20	Fabric	Cotton	Beneath the left hand of the body
21	Ibul (Soryumgeum; Inner Comforter)	Cotton and Silk	Only the outer part remains
22	Onang (for left hand)	Silk	Near the right hand
23	Jeogori (Jacket)	Cotton	
24	Nubi Jeogori (Quilted Jacket)	Silk	Purple-colored
25	Nubi Jeogori (Quilted Jacket)	Cotton	
26	Jeogori (Jacket)	Cotton	ND
27	Jangot (Long coat for women)	Ramie and Silk	
28	Jeogori (Jacket)	Cotton and Silk	Wearing under Jangot (#27)
29	Chima (Skirt)	Silk	
30	Jeoksam (Unlined Summer Jacket)	Cotton	Wearing under Jeogori (#28)
31	Baji (Trousers)	ND	Folding on the knee
32	Chima (Skirt) or Baji (Trousers)	ND	Grey-colored; Folding on the knee
33	Jeogori (Jacket)	Cotton	Foot covering
34	Jeogori (Jacket)	Cotton	
35	Baji (Trousers)	Cotton	
36	Baji (Trousers)	Cotton	
37	One piece of Beoseon (Socks)	Cotton	Near the right foot
38	Somoja (Beanie)	Cotton	
39	Aksu((Left)	ND	
40	Aksu (Right)	ND	
41	Myeokmok	ND	
42	One piece of Beoseon (Socks)	Cotton	Near the left foot
43	Jiyo (Mattress)	Silk and Cotton	
44	Onang (for right hand)	ND	Near the left side of the body
45	Baegae (Pillar)	ND	Found under Jiyo
46	Somoja (Beanie)	Cotton	
47	Somoja (Beanie)	Cotton	
48	Myeongjeong	ND	Seen in ***Figure 2***
49	Guii	ND	
50	Hyeon	ND	Near the right side of the body
51	Hoon	ND	Near the left side of the body
A	Sap	Wood	
B	Ropes (for Soryum)	ND	

Table 2 Inventory of Goryeung Clothes.

SAMPLE	SEX	AGE	δ13 C(‰)	WT %C	δ15 N(‰)	WT %N	C:N
Goryeung[a]			−20.84	45.23	11.82	14.86	3.55
Nunalleq[b]			−16	43.5	13.8	14.1	3.6
			−15.1	44.2	17.4	14.7	3.5
			−15.6	43.1	16.3	14.8	3.5
			−15.5	45.2	17.1	14.8	3.5
			−15.8	41.1	16.5	14.5	3.5
			−16.4	42.8	14.9	15	3.5
Pacatnamu[c]	ND	5–6 yrs	−12.7		13.6		
	Male	Old adult	−11.9		13.7		
	ND	Newborn	−12.4		13.9		
	Male	Adult	−12.1		11.5		
	ND	Newborn	−11.7		14.6		
Osaka[d]			−20.8	11.8			3.28
			−20.8	10.1			3.20
			−21.9	11.4			3.20
			−20.9	12.2			2.83
			−21.4	11.1			3.14
			−21.5	11.4			3.08
			−21.7	10.7			3.42
			−21.3	10.1			3.24
			−20.8	11.3			3.16
			−22.1	11.1			3.30
			−23	7.6			3.17
			−22.1	11.8			3.33
			−21.3	10.3			3.18
			−21.5	10.1			3.14
			−21.6	10.6			3.13
			−21.6	11			3.16
			−21.8	10.9			3.16
			−21.6	10.5			3.15
			−21.7	10.1			3.06
			−21.1	10.6			2.92

Table 3 Stable Isotope Data of Goryeung, Nunalleq, Pacatnamu, Osaka Samples.

[a] Current; [b] Britton et al 2013; [c] White et al 2009; [d] Maruyama et al 2018.

of Peru. Excavation revealed that the site was used from Moche (ca. 350 CE) to Lambayeque (ca. 1370 CE) period (White el al 2009). Nunalleq of Alaska is a later Thule-era site, dating to 650±40/570±30 cal BP. They were thought to have been specialized sea mammal hunters (Britton et al 2013). Osaka report was obtained from the analysis of human hairs embedded in the paper of Japanese books that were published in 1690s to 1890s (Maruyama et al 2018). The Pacatnamu, Nunalleq, and Osaka results were selected as comparable groups representing the farmers in the New World, Alaskan hunter-gatherers, and East Asian rice farmers, respectively. Statistical tests and drawing of graphs were conducted by R Statistics (R Core Team 2017).

The isotopic values obtained in our analysis are summarized in ***Table 3***. The C: N ratios of the samples fell within the range of 3–3.6, as indicative of an acceptably reliable analysis. The stable isotope values of the Goryeung case were -20.84 for $\delta^{13}C$ and 11.82‰ for $\delta^{15}N$. ***Table 3*** and ***Figure 7***

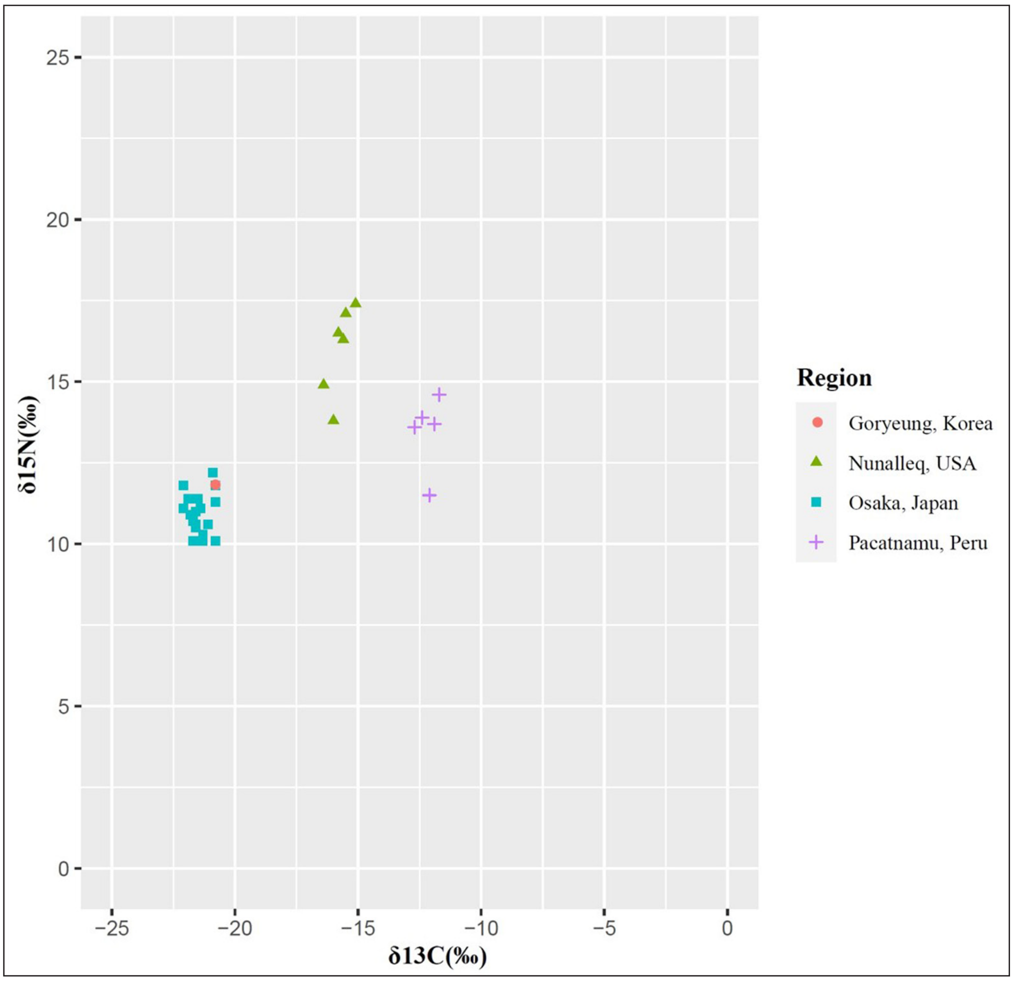

Figure 7 Stable isotope values and information of samples. The results of Goryeung (Korea), Nunalleq (Alaska, US), Osaka (Japan), and Pacatnamu (Peru).

show the stable isotope values of the Peru (Pacatnamu), Alaska (Nunalleq), Japan (Osaka), and Goryeung samples. The Pacatnamu samples showed the highest $\delta^{13}C$ values, indicating a protein-rich (possibly from marine resources or domesticated animal (e.g., llama meats) and C4-based (e.g., from maize) diet characteristic of the coastal area of Peru (White et al 2009). Meanwhile, the highest $\delta^{15}N$ value was represented by the Nunalleq (Alaska) samples from prehistoric archaeological sites in the Kuskokwhim Bay region of Western Alaska. The strikingly high values in these specimens indicated abundant intake of protein sources including marine foods such as salmonids and aquatic mammals. As for terrestrial resources, the Nunalleq people might have consumed very limited amounts of seasonal plant foods (e.g., berries, wild vegetables, and fresh greens) (Barker and Barker 1993; Britton et al 2013). Such a dietary pattern reflects a high-latitude Arctic maritime environment. Meanwhile, the samples from Osaka adduced diets reliant on a subsistence-agricultural economy representative of the lowest $\delta^{13}C$ and $\delta^{15}N$ values. We thus concluded that the 18th–19th century Osaka people might have consumed mainly marine fishes and C3 food (e.g., rice) (Maruyama et al 2018). Our data on the Goryeung individual approximated the results for the Osaka samples. Considering such similarity, analogous subsistence strategies for these two pre-20th century peoples (Osaka and Goryeung) could be postulated.

NOVEL STRATEGY FOR RESCUE ARCHAEOLOGY IN SOUTH KOREA

Scholars always want to have sufficient time for proper research. They do not relish carrying out their work on site, understandably preferring a well-equipped laboratory at a university, museum, or institute. However, circumstances often lead to difficult situations marked by limitations and constraints in terms of both time and study facilities. Often, the investigations of clothing historians or anthropologists take a few months to several years. In the context of rescue archaeology though, especially in cases where human bones from graves need to be cremated within a short time frame, anthropologists simply cannot conduct their work in a university or institute lab.

Figure 8 compares a typical investigation protocol with the modified strategy introduced in this paper. In the latter case, unlike the former, a considerable amount of research can be carried out in a field lab established at excavation site. Moreover, only remaining studies like stable isotope analysis etc. would need to be conducted at a university or institute lab. Our novel protocol in *Figure 8*, by which scientific data can be successfully secured in the excavation field, could be significant for the purposes of rescue archaeology. However, regardless of field-lab work's might be, it is still a significant challenge to archaeologists, anthropologists, and dress historians. No matter how well prepared, working in a field lab cannot be the same, for investigators, as working in a university or institute lab. In this respect, the present anthropological research covered in this report must be considered just a very preliminary step toward the establishment of a far more advanced research protocol for rescue archaeology.

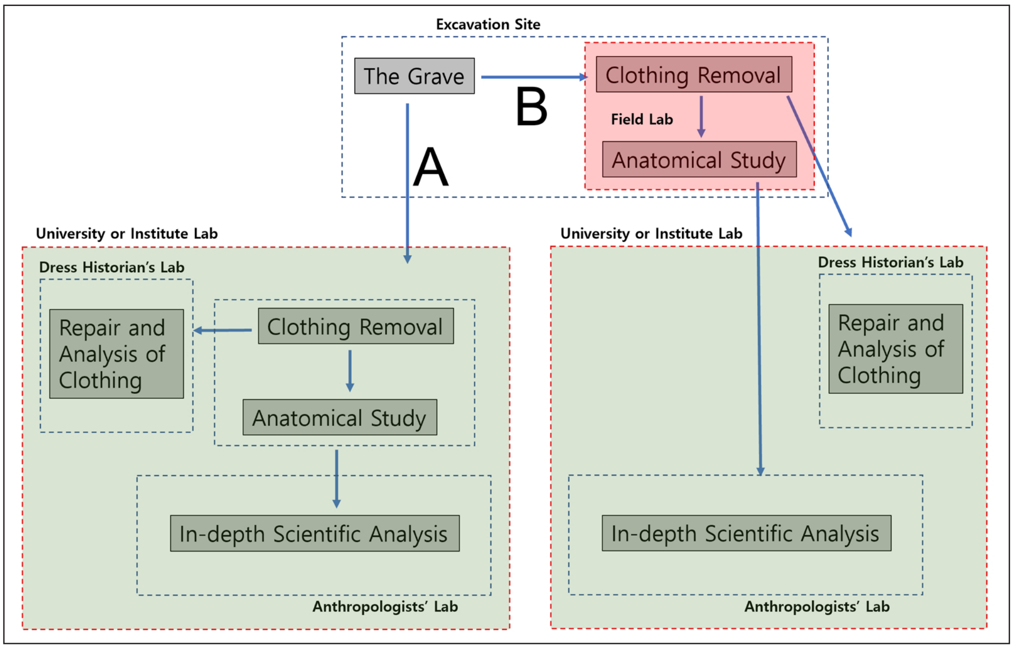

Figure 8 Procedures of **(A)** routine and **(B)** rescue technique introduced in this article. Red and green shadowed boxes represent field and university/institute lab, respectively. (A) In a typical investigation protocol, the remains of grave found at archaeological site are usually moved to university or institute labs where anthropologists and dress historians collaborate each other to remove the clothes that had enshrouded the body. The collected clothes are repaired and analyzed in a dress historian's lab. In-depth scientific analysis (e.g., stable isotope etc.) could be conducted in anthropologists' lab. (B) Rescue technique applied in the current report. The works of anthropologists and dress historians are conducted first at field lab. Clothing is removed at the field lab and then moved to dress historian's lab in university or institutes. Anthropological examination (anatomical study) is also done in a field lab; but small specimens could be moved to anthropologist's lab for further scientific analysis.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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