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Geoarchaeological observation of earlier palaeolithic (EP) assemblages of the downstream South Han River Area (SHRA), Korea

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ABSTRACT: This article introduces palaeolithic assemblages from the South Han River Area (SHRA) of South Korea and examines their ages in the geoarchaeological context. This task will be a starting point to discuss major factors responsible for the relatively late predominance of seemingly simple-and-crude Mode 1 toolkits in East Asia. Eight palaeolithic sites of the SHRA are covered and formation processes of their assemblages are examined based on geological features and published chronometric dates as well as additional proxy data. The ages of SHRA assemblages are roughly Late Pleistocene from MIS 5c to MIS 2. The lithic type variability of the SHRA is of typical Mode 1 technology which is principally composed of pebble-tools and minimally modified flakes. The issue of such a simple technology flourished in a limited area of East Asia during a quite late temporal range is discussed. A hypothetical explanation is that stone tools in the SHRA served as complementary items for making perishable primary living items out of organic materials and that local hominins were not obliged to be sedulous on such subsidiary items as stone tools. As a result, the nature of the SHRA assemblage looks apparently unlabored and expedient; this nature of lithic technology tends to be timeless and even survive anywhere anytime in East Asia, which can be recognized as retarded and not advanced.

Key words: the South Han River Area (SHRA), colluvial, post-depositional transformation, the Mode 1 technology, complementary toolkits

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1. INTRODUCTION

The South Han River originates from the highland of Taebaek City in Gangwon Province (eastern part of South Korea) and meets the North Han River, another large stream, around Paldang area (South Yangju City) to form the main Han River channel stream that traverse the metropolitan Seoul area. Its length is about 375 km and catchment area is 12,577 km reaching Gangwon, North Chungcheong, and Gyeonggi Provinces. There are several steps of Pleistocene river terrace around channel area and its upstream region is characterized by typical calcium-carbonate karst environment. The South Han River Area (SHRA) has drawn local researchers' attention since the initial era of Korean archaeology in 1960s. Constructions of large-scaled dams along channel streams enabled many palaeolithic localities to be exposed and excavated. Now about 110 palaeolithic localities in the SHRA have been identified and more than forty sites been excavated and publishd (Lee, 2018a, 2018b).

First archaeological research in the downstream SHRA began with the discovery of Yongtandong (Chungju City; Yi and Lee, 1993) and Byeongsanri (Yangpyeong County) site (Yoon and Han, 1992, 1994). Afterward, Yeonyangri, Baekseokri, and Hyeonamdong in Yeoju City; Dogokri in Yangpyeong County, Hoamdong and Mokhaengdong in Chungju City were excavated by diverse research agents (Kim and Lee, 2005; Lee, J., 2007; Lee et al., 2008; Kim et al., 2015; Kim et al., 2017; Lee, M. et al., 2019; Lee, S. et al., 2019; Shin et al., 2019). These assemblages of earlier palaeolithic (EP)—lithic industries in general before initial Upper palaeolithic

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industry (IUP; about 40,000–35,000 BP)—are primarily composed of heavy-duty tools and miscellaneous small flake-based tools (Kim, 2011; Lee, 2013, 2018a, 2019).

This article intends to introduce those assemblages and examine their ages and geoarchaeological context which can be a major factor responsible for the relatively late predominance of simple-and-crude Mode 1 toolkits. The Korean EP assemblages are generally composed of less-refined tool types which are normally assigned to Lower (Early) and Middle palaeolithic industries in the west. It is, however, noteworthy that, even until the earlier phase of Upper Pleistocene, this apparently "primitive" technology has remained unchanged and the trajectory of its change is quite monotonous seldom showing temporal and spatial diversity.

The mainstream Han River and the Imjin–Hantan River Area (IHRA) in the northern part of South Korea are characterized by Acheulian-like handaxe assemblages during the same period (e.g., Yi, 1996, 2000; Yoo, 2008, 2016, 2019a); the SHRA has, on the other hand, not witnessed recurring occurrences of handaxe and other large cutting tool types though. These two parallel lithic industries in South Korea during Late Pleistocene need examining and discussing because they can be termed an "anachronism of both Oldowan and Acheulian" in the Far East, which led Movius (1944) to address East Asian Early palaeolithic to be "retarded" either culturally or temporally.

In this sense, we would focus on two topics: 1) the geoarchaeological observation of formation process that will explain how the SHRA palaeolithic localities were formed and their relatively younger ages were obtained; 2) the seemingly unsophisticated repertoires of the SHRA lithic assemblages will be examined and discussed in the context of "non-artifactual" hypothesis with relevance to the usage of organic materials (Brumm, 2010; Bar-Yosef et al., 2012; Kononenko et al., 2021). For the purpose of these tasks, we will begin with a brief account of the Korean palaeolithic chronological/technological framework.

2. THE KOREAN PALAEOLITHIC IN GENERAL: THE CHRONOLOGY OF ITS TECHNOLOGY

Since the first discovery of palaeolithic site (the Seokjangri site in 1962), the Korean palaeolithic research has progressed with discoveries of many unique cultural/technological repertoires: 1) Jeongokri and other adjacent sites with handaxe assemblages in the IHRA (ca. 75–64 ky BP, Yoo, 2008, 2019a, 2019b), 2) the Suyanggae site complex which is a landmark of Korean IUP technocomplex (ca. 40 ky BP), and 3) numerous microliths from terminal Upper palaeolithic sites in the mid- and south-western part of the Korean Peninsula (ca. 25–10 ky BP); these terminal Upper palaeolithic assemblages show long-distance transportation (more than 800 km) of obsidian from the Baekdu (Changbai in Chinese) Mountain at the border between North Korea and China. The amount of discovered/reported palaeolithic data is now enormously increasing because of vigorous salvage excavation campaigns have been mandated for the public development projects since 2000s.

Considering many published dates of those palaeolithic sites, the first hominin occupation in the Korean Peninsula seems as old as 0.5 my BP based on some disputed titular old dates of palaeolithic sites (e.g., the Geomeunmoru Site in North Korea; Han, 2003; Yoo, 2008; Kim, 2011). A more realistic age of the earliest human occupation is, however, to be ca 0.2 my BP according to chronometric dates of unequivocally primary context of archaeological horizons (Yoo, 2008; Lee, 2018a). Before the IUP technological innovation is widespread about 40–35 ky BP, the Korean palaeolithic assemblages had not undergone any distinct technological diversification, not distinct enough to confidently apply the three-age scheme—the Lower, Middle, and Upper palaeolithic divisions—widely accepted in the west (e.g., Lee, H., 2000, 2004, 2015a, 2015b; Yi, 2000, 2001; Chang, 2007; Choi, 2010; Kim, 2012; Lee, 2012b). In this sense, we hereafter use the term "earlier palaeolithic (EP)" in general in order to incorporate the archaeological assemblages older than 40 ky as well as their context and associated features.

Large tool category of the Korean EP assemblages includes pebble-tool types and large cutting tools: choppers, chopping-tools, picks, handaxes, cleavers, knives, polyhedrons/bolas, etc. Those large-tool-dominant assemblages are mixed with simple flakes which might have been used without elaborate modification; the raw materials of those tools/flakes are exclusively low-quality materials like quartz and quartzite easily available at the site areas. These Korean EP assemblages are equivalent to Lower and Middle palaeolithic industries elsewhere although their ages predominantly belong to Late Pleistocene; it is also emphasized that no undisputed Levalloisian (Mode 3 technology) pieces are included. In this sense, local researchers are not keen on the use of the term "Middle" palaeolithic for Korean assemblages (Choi, 2010; Kim, 2012; Lee, 2012b, 2018a).

These EP assemblages persisted as late as the early MIS 3. Approaching the later MIS 3, the number of small tools increased and a tendency of rather intensive modification is frequently observed among those small tools; the raw materials generally become concentrated on the homogeneously fine-grained quartz (e.g., the Pyeongchangni and Sorori site; Lee and Woo, 2000; Yi et al., 2000). The small and fine-grained quartz tools were replaced or complemented by innovative industry, a totally different IUP technology that emerged and prospered from the terminal MIS 3 to MIS 2.

The Korean Upper palaeolithic toolkits are marked by drastic raw material shift from quartz/quartzite to microcrystalline rocks such as rhyolite, porphyry, tuff and other siliciferous rocks. Those high-quality materials were principally utilized for making advanced tools based on blade technology (Lee, H., 2004; Yi, 2001). For example, diverse small tool types—tanged point, endscraper, burin, and other miniscule tools—began to be manufactured as early as 40,000 BP with the adaptation of such intensive technology as prismatic core and pressure flaking. In addition, more delicate microlithic technology emerged ca. 25,000 BP and the exchange of obsidian and other exotic raw materials became prevalent among local hominin groups, possibly modern sapiens species (Lee, H. 2005; Chang, 2007).

Those Korean palaeolithic assemblages are generally distributed within silt/clay deposits made by alluvial and/or colluvial actions. Most Korean EP assemblages of Late Pleistocene belong to the dark and highly oxidized clay-dominant layer and their ages are determined by variable chronometric dates (Han, 2003). That clay-dominant layer is uniquely characterized by multiple horizons of wedge-shaped cracks diagnostic of cold and dry climate of MIS 4 and/or MIS 2 (Lee, D., 1994, 1995, 1996; Han, 2003); those cracks are well-developed inside clay deposit and propagate deep down more than 2 m below the loamy top soil. While their exact ages are controversial, the wedge cracks at the bottom are generally dated ca. 60 ka and the upper ones are ca. 30–20 ka (Han, 2003; Lee, 2012a, 2012b).

Some argues Late Pleistocene sediments are predominantly composed of eolian particles blown from continental Asia with typical features of Chinese loess (e.g., Oh and Kim, 1994; Kim et al., 2012). It should be emphasized that the general sedimentary environment of Korea does now show any eolian features and that reliable source of eolian-dominant phase in major palaeolithic sites is only fragmentary, not uniformly distributed. In spite of this, the pale-yellow sediments covering the upper wedge-shaped cracks show typical texture and properties of loess-like aeolian particles indicating cold and dry phase of MIS 2. These loess-like sediments can be a chronological hallmark in Korean palaeolithic, and widely distributed across the southern part of the Korean Peninsula. The age of this pale-yellow sediments is usually indicated by Aira-Tanzawa tephra (ca. 30–26 ky BP), which well-corresponds to the environmental background and age of MIS 2.

3. EARLIER PALAEOLITHIC LOCALITIES OF THE SHRA

Based on the general characteristics of Korean palaeolithic assemblages mentioned above, we now introduce some sites and lithic assemblages of the SHRA. Those assemblages are exclusively EP industry and their temporal bracket is from MIS 5e to MIS 3, roughly from 123 to 29 ky BP. The archaeological localities in the SHRA are clustered in three different regions of modern administrative districts: 1) Chungju City, 2) Yeoju City, and 3) Yangpyeong County (Figs. 1 and 2).

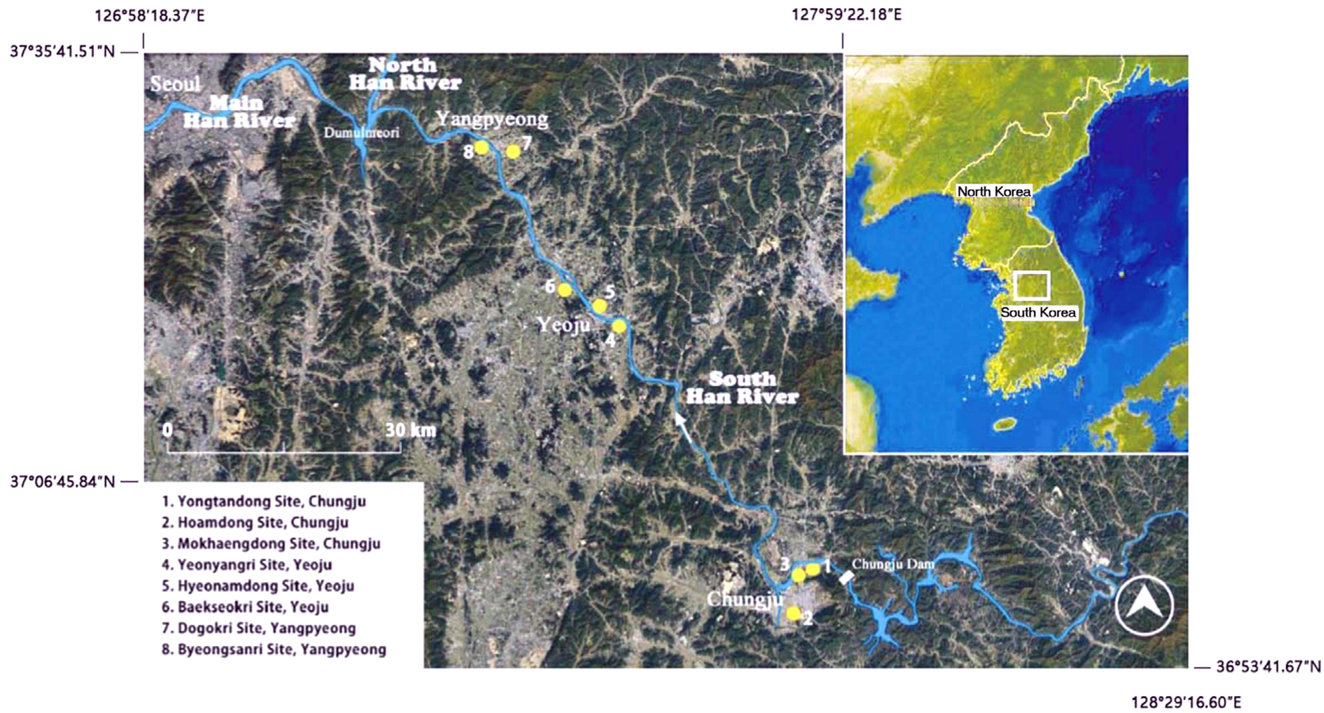

Fig. 1. The location of the SHRA and archaeological localities mentioned in this article.

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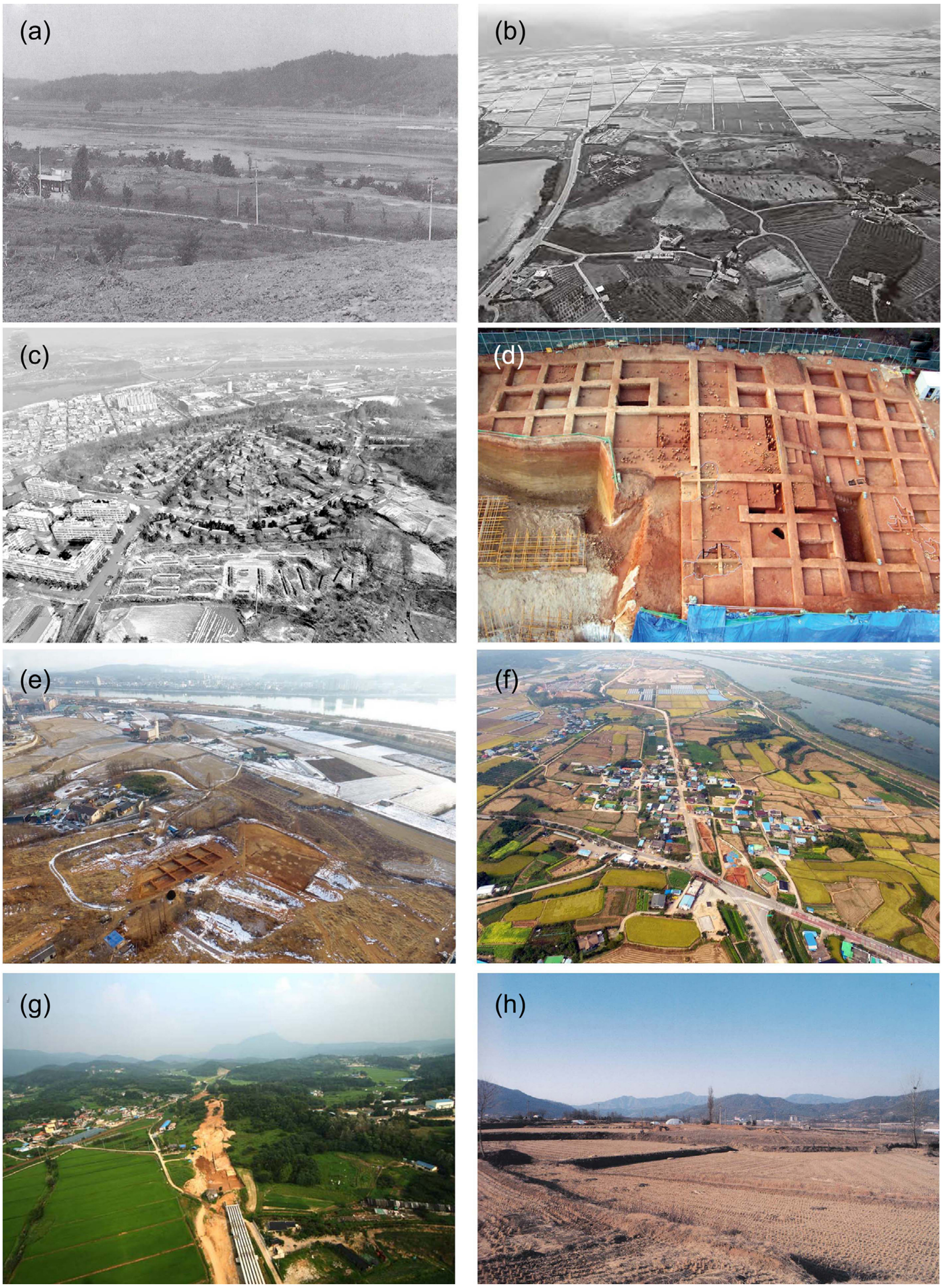

Fig. 2. The overview of the SHRA sites mentioned in this article. (a) Yongtandong, (b) Hoamdong, (c) Mokhaengdong, (d) Yeonyangri, (e) Hyeonamdong, (f) Baekseokri, (g) Dogokri, (h) Byeongsanri.

3.1. Localities at Chungju City

The first discovery of the EP sites in the SHRA is the Yongtandong site (Yi and Lee, 1993). The site area is located on the lower terrace (88 m asl.) on the southern bank of the river channel. Yongtandong is devoid of any artifact horizon; the original context seems to be washed and erased by subsequent inundation. Only two choppers were retrieved from the gravel layer at the terrace surface.

Recently discovered Hoamdong Site is near Dalcheon Stream, a small tributary flowing from the south (Kim et al., 2017). The site area is elevated (about 103 m asl.) and its stratigraphic sequence is a typical case of river terrace: from bottom to top, 1) conglomerate layer composed of large river cobble/pebble, 2) sandy silt layer, and 3) clay-dominant layer. Three artifact horizons are distributed inside the clay-dominant layer with multiple bands of diverse tones. The 1st artifact horizon is in the dark brown clay (DBC) band at the top; the 2nd is at the reddish-brown clay (RBC) band in the middle; the 3rd is within sandy silt layer at the bottom. Those three different bands possibly reflect Late Pleistocene climate changes; as an indication to the dry and cold climate, two series of wedge cracks are well-developed inside the DBC and RBC. Total 349 lithic artifacts were retrieved (301 are from the 2nd horizon) and choppers and miscellaneous flakes are dominant.

The Mokhaengdong site, about 2 km west from Yongtandong, was discovered and excavated in 2017 (Lee, S. et al., 2019). The site area is on the eastern bank of ca. 95 m elevation. Like Yongtandong and Hoamdong, the stratigraphic sequence is generally fining-upward: from bottom to top, 1) conglomerate, 2) sand-silt, and 3) clay with three differently colored bands. The clay layer on top is divided into DBC, RBC, and the pale brown clay (PBC) bands likewise. Somewhat similar to the case of the Hoamdong site, the RBC includes a series of wedge cracks and one artifact horizon of 60 specimens is identified just below these cracks. Except for a large chopper, the assemblage is primarily composed of cores, flakes, and miscellaneous chips.

3.2. Localities at Yeoju City

The largest locality in Yeoju City is the Yeonyangri site. This site is located on low hilltop (about 67 m asl.) and was excavated through two separate campaigns (Lee, J., 2007; Kim et al., 2015). Its stratigraphic sequence includes: 1) granite bedrock, 2) gravels of terrace origin, 3) sand/silt, 4) clay, and 5) loamy top soil with partly disturbed band. The artifact horizon is distributed in the clay layer which also has three different bands: from bottom to top, 1) RBC, 2) DBC, and 3) PBC. Artifacts are concentrated on the upper part of the RBC band which includes wedge cracks as well. Total 2,100 artifacts were discovered and 390 of them were retrieved from small deposits of possible swamps and ditches. Artifacts from the water-logged deposits were probably transported around river channel area. The assemblage includes choppers and other heavy-duty tools; some small tools such as scraper, notch, and denticulate are also included.

The Hyeonamdong Site was discovered and excavated in 2017 (Lee, M. et al., 2019). This site is located on the eastern bank (about 53 m asl.) of the river and the stratigraphic sequence is similar to other sites: 1) bedrock, 2) coarse sand with fluvial marks, 3) silty clay, 4) clay with pale and dark brown bands, 5) disturbed top toil. The DRC band in the clay layer has wedge cracks and six artifacts made of local quartz: chopper, scraper and other debitages.

The Baekseokri Site was excavated through two separate campaigns in 2004 and 2019 (Kim and Lee, 2005; Shin et al., 2019). This site is located on top of the western river bank and its stratigraphy is identical to those of both Yeonyangri and Hyeonamdong. Two artifact horizons—the 1st one at the DBC and the 2nd one at the RBC—were identified; 2nd horizon yielded 220 artifacts while the 1st horizon only 60.

3.3. Localities at Yangpyeong County

The Dogokri is located at the foothill of the eastern river bank. The stratigraphic sequence is slightly different from those of other upstream area: 1) bedrock, 2) gravel/sand, 3) sand, 4) clay, 5) silt-dominant clay, and 6) loamy top soil. 572 lithic artifacts were discovered from the gravel/sand layer above weathered bedrock. These artifacts were strongly influenced by post-depositional slope movement in the course of fluvial inundation. Chopper and polyhedron are main lithic types.

The Byeongsanri site was excavated two times in 1992 and 1994 (Yoon and Han, 1992, 1994). This site is situated on the lower plain (38 m asl.) at the western bank. The stratigraphic sequence well-illustrates a typical example of fining-upward river terrace sediments: 1) gravels of river terrace, 2) sand, 3) silt, 4) clay, and 5) top soil from bottom to top. The clay layer is composed of three different bands as well: from bottom to top, 1) RBC, 2) DBC, and 3) PBC. The RBC and DBC bands commonly have wedge cracks as well. 30 out of total 40 artifacts were discovered from the lower half of the DBC band. Choppers and polyhedrons are the main tool types.

4. GEOARCHAEOLOGICAL CONSIDERATION OF THE SHRA PALAEOLITHIC SITES

4.1. Location and General Topography of the SHRA

Several river terrace levels are identified in the SHRA. The upstream area with diverse tributaries has three terrace steps but downstream area has generally two (Park, 1992; Im, 1994, 1997; Song, 1998; Kim et al., 2004, 2006). These two steps are termed Lower and the Middle Terrace respectively. Compared to the Lower (about 18 m asl.), the Middle Terrace (about 30 m asl.) where Hoamdong, Mokhaengdong, Yeonyangri, and Baekseokri are discovered contains heavily weathered gravels below artifact

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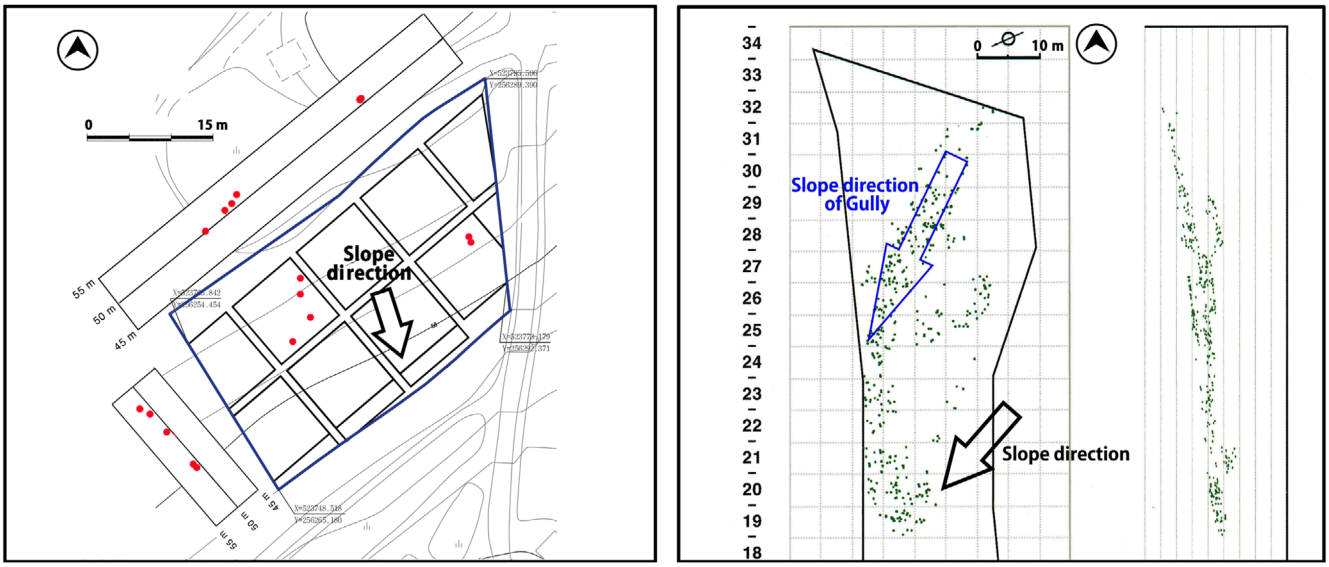

(a) Hyeonamdong (b) Dogokri

Fig. 3. Artifact distribution of two hill slope sites. (a. Hyeonamdong, b. Dogokri).

horizons; Yongtandong and Byeongsanri lack well-rounded and smoothed cobbles/pebbles indicative of heavily weathered terrace gravels though.

The maximum age of the Middle Terrace is estimated later Middle Pleistocene based on several old chronometric dates (Park, 1992; Im, 1994; Kim et al., 2004, 2006). The lithic assemblages of those four sites on the Middle Terrace above, since commonly distributed far above the terrace gravels, are estimated significantly younger than river terrace gravels.

Unlike six sites on Middle and Lowe Terraces above, two sites—the Hyeonamdong and Dogokri sites—are located at the marginal part of hillsides. Hyeonamdong is on the foothill and its outer margin contains alluvial deposits, which is diagnostic of serious inundation of adjacent river channel (Fig. 3a). As has been noted (Lee, M. et al., 2019), this site was seriously disturbed when the Lower Terrace was formed and quite a long time has lapsed afterward before the final artifact horizon was formed. Dogokri is also located at the bottom of a hillslope and artifacts are concentrated inside a gully, a small trough (Fig. 3b) along the hillslope. The Dogokri assemblage seems to be a stack of intermingled artifacts and colluvial gravels inside the gully; this sort of uncontrolled disturbance and re-working have predominantly happened during MIS 3 after the primary context of original artifacts was originally formed in MIS 4 (Lee, 2012b, 2016b).

4.2. Sedimentary Environment and its Impact on the Assemblages

Particle size distribution and magnetic susceptibility sequences (MSS) were obtained from several sites (Figs. 4 and 5). The chronometric dates of artifact horizons were published and correlated with corresponding stratigraphic data (Lee, 1994; Kim, 2007; Lee, Y., 2007; Kim and Lee, J., 2007; Kim et al., 2008; Park, 2008; Kim and Oh, 2015; Oh, 2017; Oh and Kim, 2018).

Particle size distributions of three terrace sites—Hoamdong, Yeonyangri, and Byeongsanri—commonly shows a clear fining-upward tendency. The strong dominance of silt and clay in the upper part is noticed; it can be indicated the sedimentary condition of the artifact horizons was not seriously influenced by abrupt inundation of channel streams or large-scaled diluvium. Under a relatively stable condition during this phase, however, the amount of sand particles seems to be quite constant and a steady influx of colluvium from neighboring hillslopes of the SHRA might have been continued.

The 3rd artifact horizon of Hoamdong can be explained in the same context (Fig. 4a). Dominance of clay/silt indicates that this site was under constant influence of alluvial agents, possibly from adjacent floodplains. It is also noteworthy that both sands and gravels are significantly included throughout the whole profile and their roundness/textures are far from those of typical alluvium. As such, we can conclude that minor but constant influx of colluvium has been in progress when the 3rd horizon was formed. This is supported by the low magnetic susceptibility value which well-corresponds to the deoxidized colluvium-dominant context.

However, the MSS of the clay/silt-dominant phases where most artifact horizons belong commonly indicates alluvium-dominant environment in Hoamdong and Yeonyangri (Figs. 4a

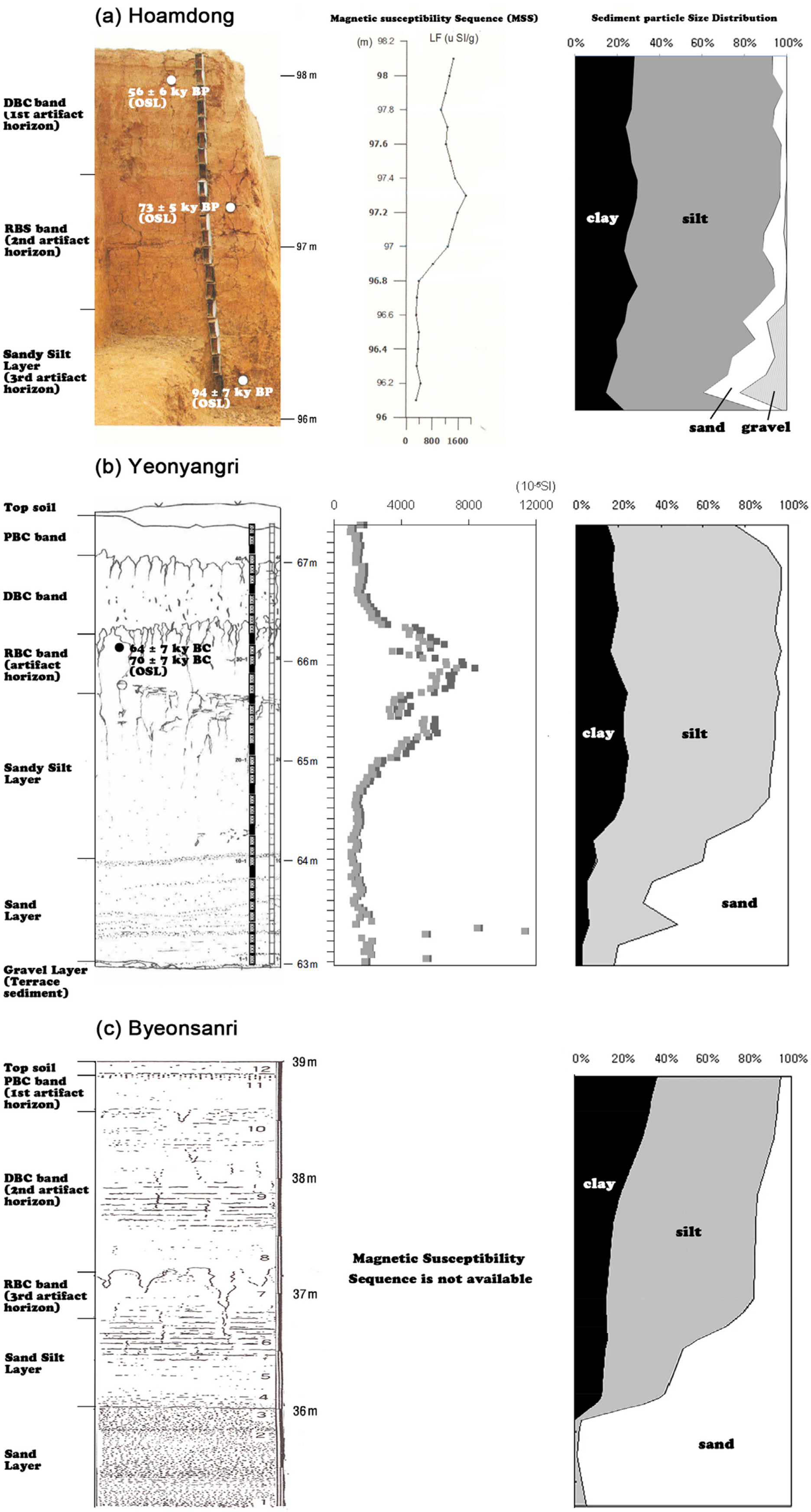

Fig. 4. Stratigraphic profiles, MSS, and particle size distributions of three river terrace sites in the SHRA.

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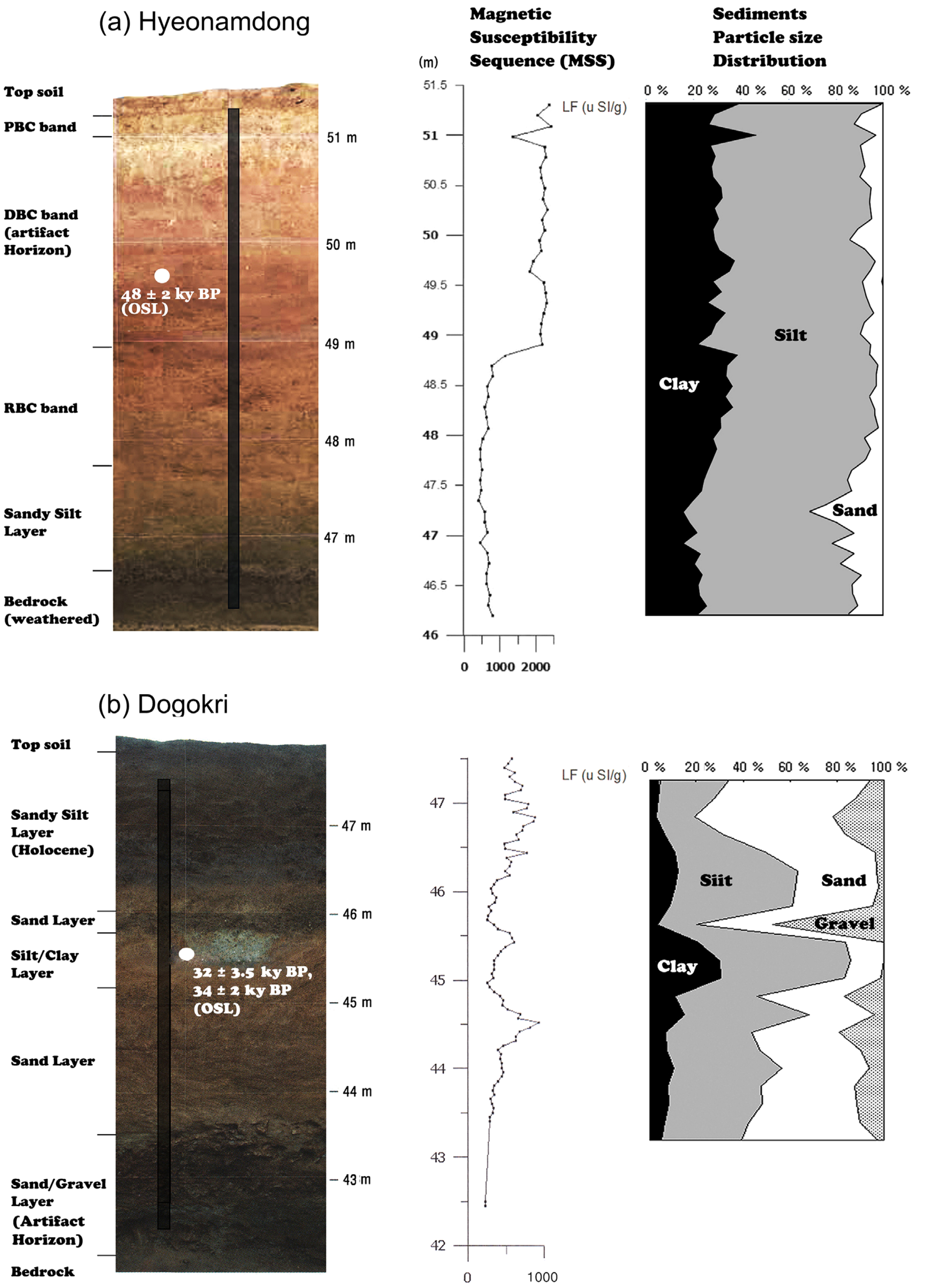

Fig. 5. Stratigraphic profiles, MSS, and particle size distributions of two hill slope sites in the SHRA.

and b). Two MSS curves are significantly pronounced around the RBC band indicating a highly increased oxidization of deposits and organic components. The Byeongsanri site, although its MSS is not available, is also believed to have a similar sequence since its sediment particle size distribution is equivalent at the RBC and DBC bands (Fig. 4c). This pronounced MSS section denotes that their artifact horizons were formed during a limited time range, when stable sedimentation began in the SHRA. The higher MSS value which corresponds to the stable sedimentation of dark-toned soils seem to be of relatively mild MIS 3 and possibly formed by fluvial actions.

The OSL dates of the Hoamdong and Yeonyangri sites correspond to this as well; the dates of the Hoamdong DBC band (1st artifact horizon) is 56 ± 6 ka BC; the RBC band (2nd horizon) is 73 ± 5 ka BC; the sandy silt layer (3rd horizon) is 94 ± 7 ka BC. All dates were measured by Korean Basic Science Institute (KBSI, Table S2 in the electronic supplementary material). The Yeonyangri sites has two OSL dates (published by Central Laboratory of Kangwon National University, KWLAB, Table S3 in the electronic supplementary material) from the upper part of the RBC band where the artifact horizon belongs: 64 ± 7 ka BC and 70 ± 7 ka BC. Those OSL dates offer a provisional age of each lithic assemblage: the three Hoamdong assemblages were made during MIS 5c, MIS 5a, and MIS 3 respectively, the Yeonyangri assemblage was formed during MIS 5a since wedge-cracks just above the assemblage indicate relatively cold and dry MIS 4.

Two sites at hillslope and gully—the Hyeonamdong and Dogokri sites—demonstrate different sedimentary environments. The MSS and particle size distribution of the Hyeonamdong site demonstrates a general fining-upward (Fig. 5a). The distribution of different sediment particles is due to irregular influx of colluvium, composed of angular gravels and sands along the hillslope. The MSS is somewhat similar to those of river terrace sites above but the susceptibility is peaked at 49 m altitude within the RBC and DBC bands. It is also significantly decreased as the clay deposit becomes pale and light. The high MSS of dark-toned clay bands seems related with milder climate of MIS 3 while the PBC band with well-developed wedge cracks of low MSS indicates cold and dry MIS 2. The artifact horizon is identified inside the DBC and its date—48 ± 2 ka BP (KBSI)—is early MIS 3.

The Dogokri site shows totally different sequence (Fig. 5b). Compared to the other sites, the Dogokri deposits have relatively high frequency of sand and gravel indicative of typical colluvium. This seems to be due to the site location. Situated inside a narrow gully, the site area was like a final destination where centripetal movements of coarse-grained colluvium happened. An artifact horizon is inside the sand/gravel layer of ca. 43 m altitude where significantly low magnetic susceptibility is observed.

We cannot clearly indicate the factors responsible for the formation of the Dogokri artifact horizon but some speculation can be made that the artifacts were rather made and discarded on the spot. The basis of this speculation is multi-facetted: 1) the lower MSS of sand/gravel layer does not indicates seriously oxidant environment where post-depositional weathering is prevalent, 2) the artifacts were gathered in situ inside the narrow gully, 3) The OSL dates—32 ± 3.5 ka BP and 34 ± 2 ka BP (KBSI)—obtained 3m above the artifact horizon adumbrates that the whole sequence was formed in a relatively short time span after the original assemblage was formed during the early MIS 3, the same age with other SHRA assemblages.

4.3. Summary: Stratigraphic Correlation and Age Determination of the Lithic Assemblages

The site locations, general topography, and stratigraphic sequence can be synthesized to build a correlation scheme of the SHRA archaeological horizons and to determine reliable ages of the assemblages (Fig. 6). The Mokhaengdong and Baekseokri sites of which chronometric dates are not published will be correlated according to proxy data.

Stratigraphic sequences of sites on the Middle Terrace are summarized to two origins of sediment: the alluvial and the colluvial ones. The sandy pebbles/cobbles were deposited by fluvial actions around river terraces. The sandy silt and clay layer were primarily formed by colluvial actions originating from adjacent hillslopes. Except for the Yongtandong, the SHRA artifact horizons are distributed inside the silt/clay layers. Their temporal range is bracketed between MIS 5e and MIS 2 based on the chronometric dates as well as sediment analysis and the MSS. The age of silt-dominant layers below is dated MIS 5c while the clay layers above are dated from MIS 5b to MIS 2. The clay layer includes three different subunits (bands): the RBC (with wedge cracks), DBC (with wedge cracks), and PBC bands from bottom to top. The RBC band is generally dated MIS 5b–MIS 4; the DBC is from the latter part of MIS 4 to the early MIS 2; the PBC band is dated the final phase of MIS 2.

The RBC band yields the largest assemblage predominantly composed of heavy-duty tools. The age of two artifacts from Yongtandong is conjectured to be around Late Pleistocene after the age of the Lower Terrace; their age seems coeval or slightly earlier than the 3rd horizon of the Byeongsanri site which is also located at the Lower Terrace.

The Hyeonamdong site, situated on the hillslope, does not have terrace gravels but weathered bedrock; its sandy silt layer at the lower part is a typical example of alluvial deposits. The artifact horizon at the DBC band is dated MIS 3 (48 ± 2 ka BP OSL dates, see Table S4 in the electronic supplementary material). Its stratigraphic sequence is in general equivalent to those of

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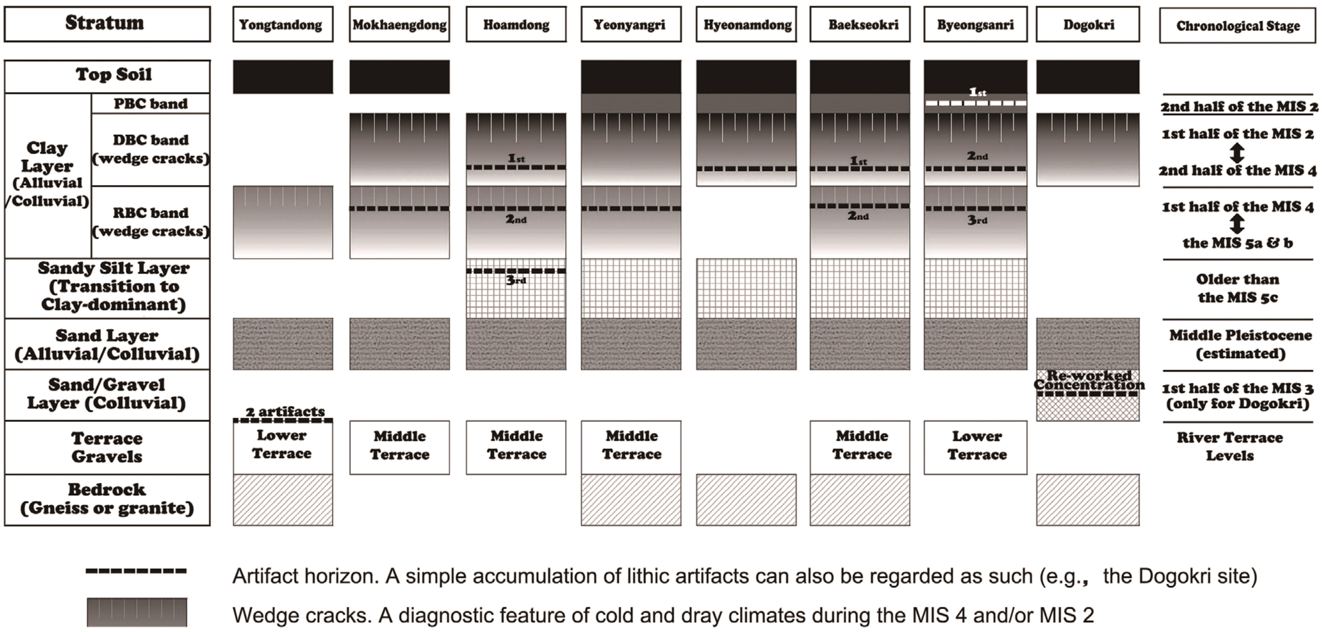

Fig. 6. Schematic correlations of the 8 SHRA sites and their chronological relevance.

other SHRA sites located on the Middle Terrace; the tones and particle sizes of the RBC and DBC are quite similar and homogeneous across the SHRA, enough to be correlated from site to site.

The Dogokri site inside the gully show a unique stratigraphic sequence. Its assemblage was influenced by constant influx of colluvium. The impact of large-sized gravels originating from nearby hillslopes might have damaged original context. The quantity of the colluvium was irregularly changed by dint of unexpected slope washing process as well as erosions caused by mass movement. In spite of this unstable sedimentary environment, the original Dogokri artifact horizon was generally formed in situ and scarcely disturbed during the earlier part of MIS 3. Considering the site location and the OSL dates of the silt/clay layer above the horizon, the context of original horizon was not seriously damaged inside the gully and lithic assemblage does not show any abrasion mark. It can be thus assumed that the current position of assemblage is an accumulated trajectory of hominin behaviors and post-depositional movement which is quite trivial.

Summing up the general formation processes of the artifact horizons in the SHRA (Fig. 6), we can reconstruct a chronological framework: 1) The 3rd artifact horizon of Hoamdong was formed before or during MIS 5c; 2) the 2nd horizon of Hoamdong and those of Mokhaengdong, Yeonyangri, Yongtandong, 2nd horizon of Baekseokri, and 3rd horizon of Byeongsanri are dated between MIS 5a/b and earlier MIS 4; 3) the 1st horizon of Hoamdong, the 1st horizon of Baekseokri, and entire horizons of Hyeonamdong/Dogokri are from the later MIS 4 to earlier MIS 3; 4) the 1st horizon of Byeongsanri belongs to later MIS 2. Except for the Byeongsanri 1st horizon, the age of those SHRA archaeological horizons all fall to Late Pleistocene and can be categorized as the EP assemblages. The next chapter will examine those assemblages in more detail.

5. LITHIC TOOL TYPES AND ASSEMBLAGE VARIABILITY

We have synthesized the geoarchaeological data and generalized that the SHRA sites were generally formed under alluvial and colluvial condition. Even though some—the Yongtandong and the Dogokri sites—lost their original context, the lithic assemblages are not seriously disturbed and generally discovered inside well-sorted clay layers. Their assemblage sizes, the number of total artifacts discovered, remarkably differ from site to site though (e.g., only 2 artifacts at Yongtandong site, total 60 artifacts and only one shaped tool from Mokhaengdong, 2,108 from Yeonyangri). In this article, we focus on three largest SHRA assemblages to examine the lithic type-composition and the manufacturing technology: 1) 301 specimens from the 2nd horizon of the Hoamdong Site (Ho-2A), 2) 572 specimens from the re-worked Dogokri assemblage (DoA), and the 3) 2,108 specimens of the Yeonyangri site (YeA).

These three assemblages are commonly composed of heavy-duty tools and miscellaneous debitages. The large-tool category includes choppers, chopping-tools, polyhedrons, and handadzes. Chopper is the most dominant type; the Ho-2A has 6 choppers

Table 1. Number of choppers and large tools from the SHRA assemblages

Context of discovery	Lower Terrace	Sand/Gravel Layer	Sandy Silt Layer	RBC band				DBC band		
Artifact horizon	Yongtan-dong	Dogokri	3rd of Hoamdong	2nd of Hoamdong	Mokhaeng-dong	Yeonyangri	3rd of Byeo-ngsanri	1st of Hoamdong	Hyeonam-dong	2nd of Byeo-ngsanri
Number of Large Tools	2	103	2	19	1	54	1	6	1	11
Number of Choppers (Chopping-tools)	2 (1)	69 (15)	1 (0)	6 (1)	1 (1)	45 (2)	1 (0)	4 (0)	1 (0)	8 (2)

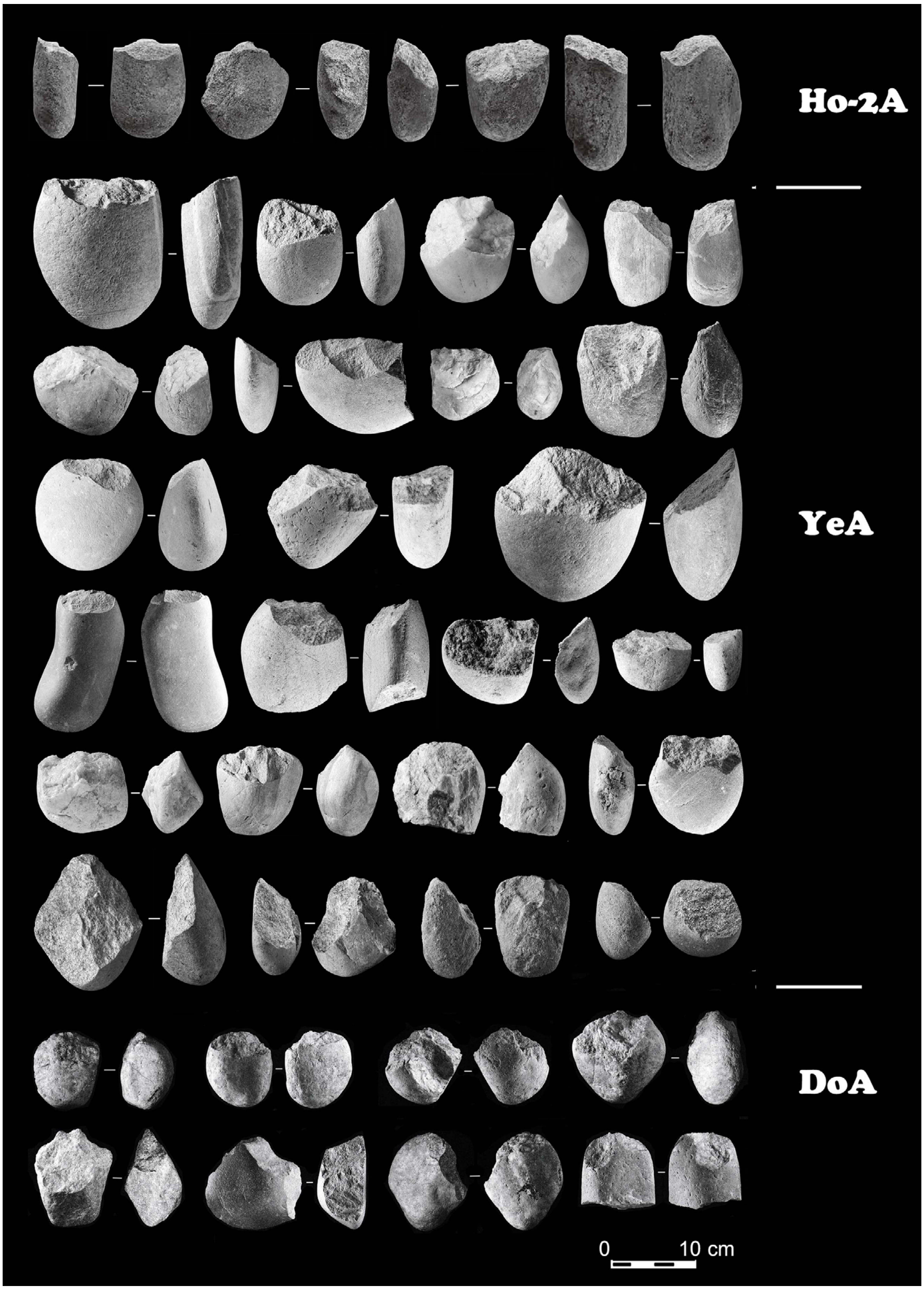

Fig. 7. Choppers and chopping-tools retrieved from the 2nd horizon of the Hoamdong site (Ho-2A), the Yeonyangri site (YeA), and the Dogokri site (DoA).

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out of 19 large tools; the DoA has 69 out of 102; the YeA has 45 out of 54. Two subtypes—the single-sided simple chopper and double-sided (or bifacial) chopping-tool—are included but the simple chopper is more frequent. Other smaller assemblages—the Yongtandong, and the Byeongsanri assemblages, for example—also include higher percentage of large tools (Table 1) and the most prominent type is the simple chopper as well. In this sense, the representative lithic tool type of the SHRA assemblages is the chopper with single-side modification. Any types—handaxe, cleaver, knife, and large scraper, etc.—of the large cutting tool category are rarely, if any, included in the whole SHRA assemblages though.

Choppers of the Ho-2A, the DoA, and the YeA are made of round quartz/quartzite cobbles, possibly from the outcrops of river terrace deposits (Fig. 7). Their sizes seem to be controlled; its length is 60–190 mm, width 50–160 mm, and thickness 30–100 mm. The general shape is ovate and elongated regardless of whether simple chopper or the chopping-tool. The edge shape is straight or slightly convex and the edge angle is about 60 degrees. The length of modified edge is about 35% of entire periphery but the choppers of the DoA are as high as 50%. The longer edges in the DoA group is possibly attributed to the higher frequency of chopping-tools since cobble blank is more recursively modified upon bifacially detaching flakes.

Chopper is globally the most common and simplest stone tool type since the very earliest tool-making habitude of hominins ca. 3.3 my BP (Balter, 2015; Harmand et al., 2015). This is the same case in the Korean Peninsula (Choi, 2010; Kim, 2012; Lee, 2012b). What is intriguing is that palaeolithic assemblages around the main stream Han River and the North Han River, another large tributary in the North have unequivocal handaxes and picks which have distinct pointed tips and lateral edges. The SHRA assemblages, however, lack any patterned large tools but have rather simple and unelaborate tools such as choppers and chopping-tools (Lee, 2013). The sharp contrast of those two lithic industries at the Han River channel system needs some explanation in the future.

6. DISCUSSION: WHY ARE THEY SO LATE AND NOT ADVANCED?

It is widely assumed that Asian EP is characterized by unsophisticated tool morphology and broad raw material selective range (e.g., Movius, 1944; Chauhan, 2007; Yoo, 2016). The unprepared flaking patterns and generally low intensity of tool modification are those of typical Asian Mode 1 technology (e.g., Watanabe, 1984; Lee, H., 2000; Guan et al., 2018; Xie et al., 2020). The SHRA assemblages are characterized by uniform and homogeneous chopper-dominant Mode 1 technology. Given the East Asian EP industry is generally dull and unsophisticated (Movius, 1944; Watanabe, 1984), the pure Mode 1 technology other than the SHRA is very common in entire Asia (e.g., Patania et al., 2020; Xie et al., 2020). In addition, it is noteworthy that some contemporary lithic assemblages show independently developed Mode 2 or even Mode 3 technology (Hu et al., 2018; Li et al., 2019) within continental Asia.

Upon this complicated technological signature of Asian palaeolithic, some hypothesis can be suggested and discussed in order to elucidate the reason why apparently anachronistic industry can survive and flourish in the SHRA. The raw material of the SHRA industry is limited to quartz and quartzite. The quartz normally exists as quartz vein and is included inside the bedrock; the quartzite is a more granular rock type made by the metamorphosis of sedimentary sandstones. Both raw materials are easily accessible and abundant around the river terraces of the SHRA. As such, they are the most reliable—easily accessible and hardly depletable—rock types in this area, similar to other areas of the Korean Peninsula and the continental Asia before the emergence of the Upper palaeolithic technology (Fang, 1994; Leng, 1998; Bae and Bae, 2012; Guan et al., 2018).

The quartz and quartzite were available in the forms of globular cobbles and/or angular slabs with an appropriate size (less than 200 mm in the maximum length). The median dimensions of choppers from Ho-2A, YeA, and DoA are about 140 × 110 × 70 mm (Table S1 in the electronic supplementary material), which make them seizable and maneuverable with a single hand. This adequate size of the SHRA choppers enabled hominins to utilize them either as casual implements or as recurrently detachable cores. As Leng (1998) mentioned, quartz and quartzite pebbles might not be the most desirable rock materials because they fracture in unpredictable ways; in addition, the round surface of river pebbles do not render suitable platform angles so that the shockwaves of percussion can propagate deep inside, enough to detach sizable flakes. Due to these critical disadvantages, choosing cobbles of proper sizes and forms for grasping securely was foremost important. The relatively flatwise oval forms might be preferred for better platform configuration to facilitate initial flake detachment (Yoo, 2016).

We did not attain any good results of use-wear analysis of the SHRA choppers; a rudimentary microscopic observation denotes that they were possibly used for some animal resource processing (Kim et al., 2015). In fact, lithic use-wear is extremely difficult to survive on quartz specimens (Pedegnana et al., 2018; Akoshima et al., 2020) and the evidence of plant-processing is rarely identified because of organic residues of plants are easily washed off by subsequent tasks and post-depositional transformation. Besides, distinguishable use-wear is only produced after several hours of strokes as demonstrated by recent experiments

(Kononenko et al., 2021). The SHRA choppers seem to be far from specialized tools exclusively used for limited tasks and originally intended from initial manufacturing stages. The multipurpose tools were always prevalent throughout the entire palaeolithic context, even in the domain of the Upper palaeolithic technology in Korea (Akoshima et al., 2020), and the SHRA choppers are not an exception from those stereotypes of palaeolithic behavioral implications.

The SHRA industry lacks any pointed tools such as picks and handaxes. Choppers and other pebble-tools are characterized by very limited modification. They do not assume any functional efficiency since their general shapes are neither pointed no sharp-edged. Any blows with these simple and obtuse tools will produce moderate impacts on organic materials exploited for the successful survival of the hominins; the size and the sharpness of their edge will not allow unfailing procurement of wild staples such as animal tissues and/or plant resources. The utilitarian limitation of those tools necessitate other materials to be alternatively secured for some substitute and complementary tools. As has been early suggested elsewhere, the usage of bamboo as tools can be an option and it has been a dominant candidate that can explain the simple pebble-tools with lack of large cutting tools in Asia (Westergaard and Suomi, 1995; Brumm, 2010; Bar-Yosef et al., 2012). Ethnographic studies also emphasize bamboo as a reliable raw material in Asian monsoon area and it has been mass-produced and widely used even now (Fortier, 2009; Pérez et al., 2014).

Aside from bamboo, some shrubs and perennially abundant plant shafts can be easily obtained and processed with dull pebble-tools which can be casually produced and discarded on the spot. In addition, if the SHRA hominins intended to carve and peel the plant materials for special purposes, small flakes would excellently serve that task and they would have "easy-come-and-easy-gone" by care-free manipulations of suitable pebble cores. As such, we can assume that the pebble-based tools of the SHRA have viably played a minor role within total tool spectrum; materials, possibly wood and some fibrous plants, other than stone might be the principal components of their living gadgets and the stone tool was just complementary, not independent, items.

Even though crucial for hominin survival and indispensable for making originally intended organic tools, the lithic assemblage of the SHRA would have been treated as either by-product or leftover. The production of pebble-tools tends to be unorganized and its *chaîne opératoire* is consequentially unmodularized; in other words, it does not conform to the multiple modes of selection-and-execution that were settled by recurrent productions of intended designs (Yoo, 2016). As a result, the SHRA assemblage might have assumed unlabored and cursory nature. Because hominins were not obliged to be sedulous on such a subsidiary living item, this nature tends to be timeless among hominin groups and even survive any time and place until Mode 1 technology was imperatively replaced by such innovative technologies as Mode 2, ground stone tools, or metallurgy (e.g., Movius, 1944; Watanabe, 1985; Chauhan, 2007; Marwick, 2008; Patania et al., 2019; Xie et al., 2020). This hypothesis—stone tool as a complementary item for other important producer goods—cannot be easily verified in the archaeological context though. Nonetheless it can facilitate discussions and contribute to the building of proper middle-range theories that will be tested with available archaeological/experimental data sets (e.g., Bar-Yosef et al., 2012) as well as some ethnographical accounts.

7. CONCLUSION

In this article, the EP assemblages of the SHRA, Korea, were introduced and their general context was examined with emphasis on the geoarchaeological features. The nature of apparently simple chopper-dominant toolkits of the SHRA were discussed and some hypothetical factors were suggested. Several points for future research can be summarized.

– The SHRA localities are situated on low hillsides near the South Han River channel; these hillsides were formed via mixture of alluvial and colluvial deposits above river terrace gravels.

– Two levels—the Middle and the Lower Terraces—of the SHRA terrace system are identified at the downstream area and their estimated ages indicate the maximum oldest ages of lithic assemblages discovered on those terrace levels.

– The Hyeonamdong site and the Dogokri site are located at the marginal part of lower terrains such as foothill and gully. Their lithic assemblages were influenced by subsequent colluvial actions. Hence, the deposits of those two localities underwent different environments from other SHRA sites.

– The upper part of the SHRA stratigraphic sequence is clay-dominant, composed of well-sorted colluvial/alluvial sediments formed under generally stable conditions. Most lithic assemblages are distributed within this part. This clay-dominant layer is divided into three sublayers: the RBC, DBC, and the PBC band from bottom to top.

– The RBC and DBC have well-developed wedge cracks indicating cold and dry MIS 4 and MIS 2 climates. Their particle size distributions and magnetic susceptibility sequences (MSS) denote that their artifact horizons were formed between MIS 5c and MIS 2. Several OSL dates of those horizons well-correspond to this temporal range as well.

– The SHRA lithic assemblages are of the typical EP industry and they commonly include simple pebble-tool types without

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such large cutting tools and/or pointed tools as handaxe, pick, cleaver, knife, and large scraper.

– Compared to other parts of the Korean Peninsula, the SHRA assemblages are characterized by simple choppers, polyhedrons, and handadzes (the Mode 1 technology). The raw material is exclusively quartz and quartzite easily obtained at the vicinity of river channels.

– The unlabored nature of the SHRA lithic assemblages can be hypothetically explained: the SHRA hominins possibly did not carry a modularized technological organization, which is formulated and maintained by a settled *chaîne opératoire*. This is due to the low necessity to produce elaborate lithic tools because simple pebble-tools and other perishable materials would have been sufficient enough for them to survive in the local environment.

The contradictory nature of the SHRA lithic industry—the seemingly outdated Mode 1 technology with significantly young age of Late Pleistocene—casts important questions on the diverse issues of East Asian palaeolithic research: 1) what made the simple and underdeveloped technology effectively adopted by local hominins during the later phase of human evolution, and 2) are there any specific reasons explaining those conservative and "obstinate"—neither genetically nor culturally but only technologically—adherence to the overdue items which have already expired way back before Middle palaeolithic of the western hemisphere? Some alternative explanatory treatments need to be implemented in the East Asian palaeolithic research to pursue satisfactory answers for these questions.

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