doi:10.17746/1563-0110.2023.51.3.096-108

**J.Y. Kim[1, 2], Y.J. Lee[2], J.Y. Woo[2], S.W. Lee[2], H.S. Suh[3], K.J. Kim[1], H.J. Yang[4], K.W. Lee[5], W.H. Choi[6], and K.C. Oh[7]**

*[1]Korea Institute of Geoscience and Mineral Resources,*
*124 Gwahak-ro, Yuseong-gu, Daejeon, 34132, South Korea*
*E-mail: asqua2017@naver.com; kjkim@kigam.re.kr*
*[2]Institute of Korean Prehistory,*
*120 beon-gil 25, Yongambuk-ro, Sangdang-gu,*
*Cheongju, Chungbuk, 28736, South Korea*
*E-mail: leeyj@ikp.re.kr; woo10@hanmail.net; arch152@hanmail.net*
*[3]Korea Research Institute of Standards and Science,*
*267 Gajeong-dong, Yuseong-gu, Daejeon, 34113, South Korea*
*E-mail: hssuh@kriss.re.kr*
*[4]Korea Astronomy and Space Science Institute,*
*776 Daedeuk-daero, Yuseong-gu, Daejeon, 34055, South Korea*
*E-mail: hjyang@kasi.re.kr*
*[5]University of Wyoming,*
*1000E. University Ave., Laramie, WY, 82071-2000, USA*
*E-mail: kyongwoo@gmail.com*
*[6]Convergence Technology Research Institute for Cultural Heritage,*
*19, Nakseongdae Station-gil, Gwanak-gu, Seoul, 08793, South Korea*
*E-mail: wonhosori@hanmail.net*
*[7]Institute of Quaternary Environment,*
*566 Daedeokdae-ro, Yuseong-gu, Daejeon, 34121, South Korea*
*E-mail: okc1027@daum.net*

# Morpho-Stratigraphy, Sedimentology, and Radiocarbon Chronology of Suyanggae Sites, Focusing on Loc. VI, South Korea

*We reconstruct the processes of sedimentation at the Suyanggae Paleolithic sites, geomorphologically characterized by fluvial terraces in the Namhan River, the base level of which is higher than the present river bottom. The fluvial sedimentary deposits, slope deposits, and paleosols are the main units of surficial deposits, constituting the site materials of Suyanggae Loc. VI. According to the representative profiles of the site, the deposits comprise sands and gravel at the bottom part, while sands and flooding muds with occasional intercalations of reddish-brown slope muds, as well as rounded or subangular cobbles or boulders, dominate the middle to upper part. Regarding the terrace's morpho-stratigraphy, Suyanggae Loc. VI is located above the low (second) fluvial terrace. Considering the chronology of site material formations, Suyanggae Loc. VI was formed in the last glacial period. On the basis of radiocarbon dates obtained for the charcoals from Suyanggae Loc. VI, the age of cultural layers is determined. Cultural layer 2 was formed in the late Upper Paleolithic, and CL 3 and CL 4 are associated with the early Upper Paleolithic. The archaeological assemblage of Suyanggae Loc. VI is described: lithic*

Archaeology, Ethnology & Anthropology of Eurasia 51/3 (2023) 96–108 E-mail: Eurasia@archaeology.nsc.ru

*artifacts of CL 2 are characterized by abundant microblades (ca 20 ka BP, Last Glacial Maximum), while those of CL 3 and CL 4 are associated with tanged points and blades (36–42 ka BP, middle of the last glacial period). Especially noted are a line-engraved cobble stone excavated from the sedimentary matrix of fluvial origin, and a face-engraved pebble stone found in flooding muds. The finds are interpreted as manifestation of symbolic human behavior.*

Keywords: *Suyanggae Loc. VI, site formation process, paleosols, microblades, tanged points, Upper Paleolithic.*

## Introduction

Suyanggae Paleolithic sites (Cultural Heritage Site No. 398) are located near the settlements of Aegog-ri (Suyanggae Loc. I and Loc. III) and Hajin-ri (Loc. VI), in Danyang County in Chungbuk Province (Fig. 1), central part of the Republic of Korea. Three excavation localities include Loc. I, Loc. III, and Loc. VI (Lee Y.J., 1989, 2000a, b; 2007; Lee Y.J., Yoon, 1992, 1993; Lee Y.J., Kong, 2004; Lee Y.J., Woo, Kong, 1999; Lee Y.J. et al., 2013a, b; 2018; Kim J.Y., Lee Y.J., 2005, 2006; Kim J.Y. et al., 2017, 2020; Kim K.J. et al., 2021; Oh, Kim, 2018). Suyanggae sites are geomorphologically associated with the marginal part and flooding bank of the upstream Namhan River (Fig. 2). The fluvial terraces, the base level of which is higher than the present river bottom, are surrounded by relatively steep mountains and meandering cores along the upstream Namhan River. Deposits in localities I, III, and IV are overlain by sand and gravel derived from the old Namhan fluvial process. Among the three Suyanggae sites, the topographic setting of Loc. III is the uppermost part of the elevation (Fig. 2). Loc. I is situated on the lower terrace (second FT) at an elevation of about 125–127 m a.s.l. (115 m above the present river bottom). Loc. VI is composed of old riverbed sands dominating the level above


*Fig. 1.* Locations of Suyanggae sites, Loc. I–VI.

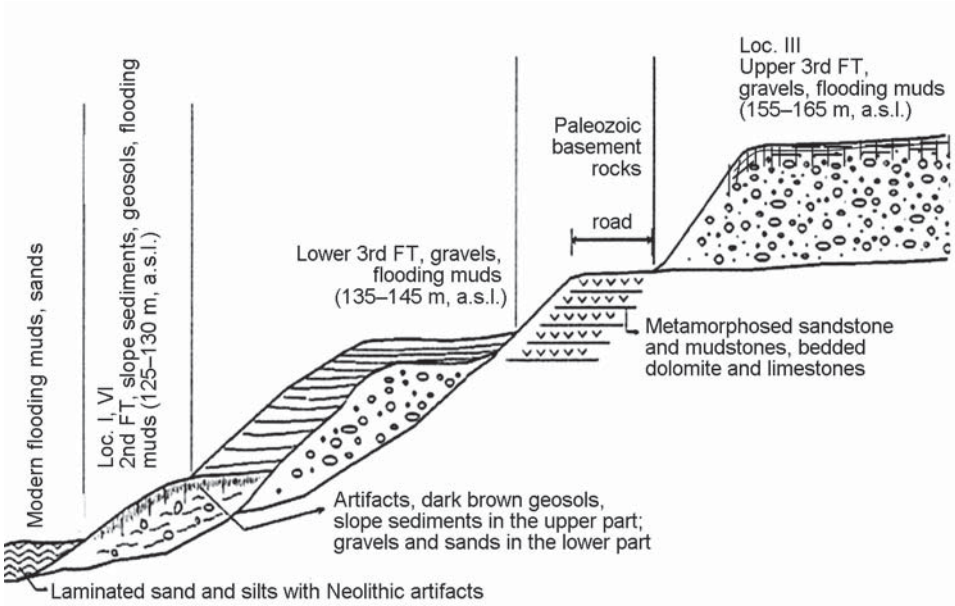


*Fig. 2.* Morpho-sedimentary implications of Suyanggae sites from the present riverbed to the third fluvial terrace, near the Danyang area.

121–126 m a.s.l. In all Suyanggae sites, either slope sediments or paleosols overlay fluvial deposits. The fluvial sediments underlie the paleosols, which are geosols associated with soil wedges and fragipans, formed during the freezing and thawing process of the Glacial Period. Paleosols are ubiquitously developed and observed in many Paleolithic sites in Korea (Kim J.Y. et al., 2016). Along the riverbank of Chungju Dam, both Suyanggae Loc. I and Loc. VI belong to the submerged parts of the hydropower dam. At several Suyanggae sites, cultural layers are associated mainly with paleosols and/or slope deposits. Some lithic artifacts are found in the lowermost part of reddish-brown paleosols; however, most often, finds (e.g., tanged points, blades, microblades, cores, end scrapers, and so forth, as illustrated in Suyanggae Loc. VI) are associated with yellowish-brown or dark-brown paleosols belonging to the Upper Paleolithic. The purpose of this study is to illuminate the site-formation process in the geoarchaeological background of Suyanggae Loc. VI.

## Morpho-stratigraphy and chronological background

Suyanggae Loc. VI (address: 302 Hajin-ri, Jeokseong-myeon, Danyang, Chungbuk Province) is adjacent to two distributary streams (Sangri-cheon from the north and Danyang-cheon from the south) of the Namhan River, where the incised meandering and longitudinal bars are observed in the riverbed. Suyanggae Loc. VI was excavated consecutively for three years (2013–2015) before the construction of the submerged embankment, up to about 132 m a.s.l. (Fig. 2). During the excavation survey, the water level of the dam was maintained at around 125 m a.s.l. The excavation site was situated approximately 125 m a.s.l. toward the Namhan River and 132 m a.s.l. toward the hillslope margin. Suyanggae Loc. VI is situated above the second fluvial terrace (Fig. 2). The representative lithologic profile is recorded in grid -5D toward the hillslope margin (Fig. 3), where fluvial deposits and mudflows intercalated with debris are conspicuous. Sandy muds are more abundant between 122 and 123.7 m a.s.l., perhaps due to flooding episodes in the paleo-Namhan River. C–M patterns of fine-grained sediments in the representative profile of Suyanggae Loc. VI indicate that these were derived from both the suspension process of the paleo-Namhan River and mudflows linked to the slope process (Kim J.Y. et al., 2020) (Fig. 4). Below 127.3 m a.s.l., suspension loads of flooding muds and fine sandy muds are dominant, while over 127.3 m a.s.l., mudflow is a conspicuous transporting process, mostly derived from the northwestern

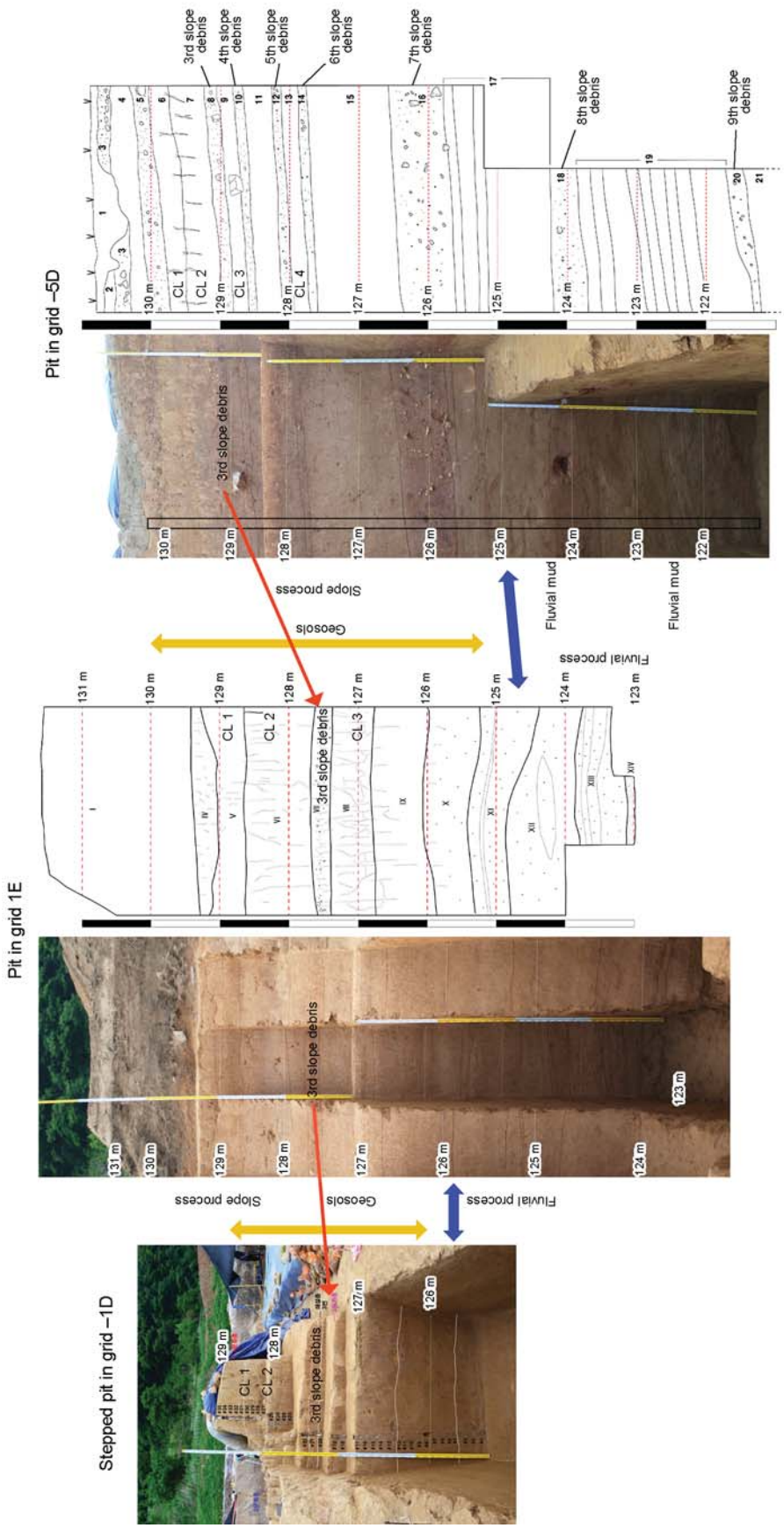


*Fig. 3.* Lithological profiles of three pits (grids -1D, 1E, and -5D) in the transverse direction of the Namhan River in Suyanggae Loc. VI.

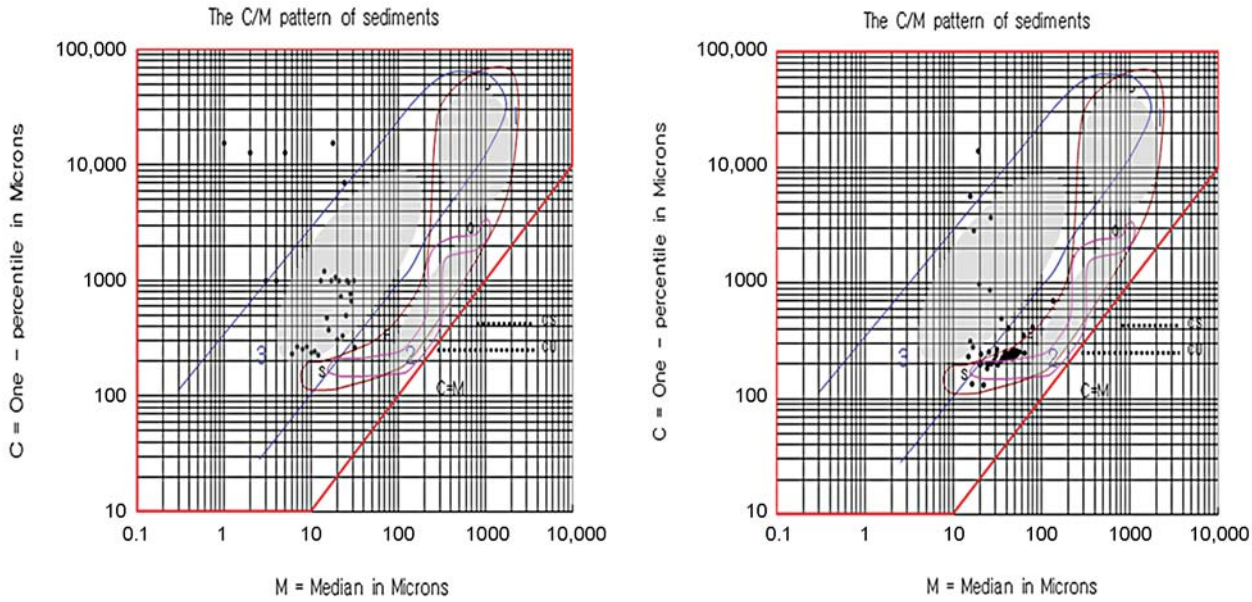


*Fig. 4.* C/M-patterns of both slope-derived deposits (SD) and fluvial sandy mud deposits (FD) of Suyanggae Loc. VI. SD is dominant above 127.3 m a.s.l., while both SD and FD are mixed between 127.3 and 123.7 m a.s.l.

hillslope margin. Sandy muddy loams, such as paleosols, are mainly distributed between 128 and 130 m a.s.l.; these were transported mainly by mudflows, which originated from the hillslope process rather than the fluvial process of the paleo-river.

Cultural layers (CL) 2 and 3 are linked to yellowish-brown paleosols, but CL 4 to reddish-brown paleosols (see Fig. 3). According to the projection diagram of artifact production vs. the elevation perpendicular to the NNW–SSE grids of Suyanggae Loc. VI (Lee Y.J. et al., 2018), CL 4 is mostly separated from CL 3 toward the hillslope over about 128 m a.s.l. (grids 4C–6A), but mixed with CL 3 between 126 and 128 m a.s.l. (grids 3A–1C) (Fig. 5). About 126 m a.s.l. (grids 1B–3G), many artifacts are predominantly produced with CL 3; artifacts from CL 4 become less diversified, except the tanged points. The radiocarbon age of CL 2 in the matrix of yellowish-brown muddy paleosols ranges between 17,550 ± 80 BP and 20,470 ± ± 70 BP (average age: 18,410 ± 70 BP, or 22,467–22,023 cal BP). This corresponds to the initial cold and dry period of the last glacial maximum (LGM) (see *Table*). The radiocarbon age of CL 3, composed of the yellowish-brown muddy paleosols, ranges widely between 30,360 ± 350 BP and 44,100 ± ± 1900 BP (average age: 35,180 ± 450 BP, or 40,172–39,321 cal BP). The radiocarbon age of CL 4, which comprises reddish-brown muddy paleosols, ranges between 34,620 ± 190 BP and 46,360 ± ± 510 BP (average age: 36,980 ± 350 BP, or 41,874–41,254 cal BP). Taking the average radiocarbon age into account, CL 4 is approximately 2000 years older than CL 3 (Lee Y.J. et al., 2018). At Suyanggae Loc. VI, in CL 2, the artifacts, such as microblade cores, scrapers, and blades, were found (Fig. 6). Blades and tanged points were discovered in CL 3 and 4 (Fig. 7, 8). Line-engraved cobble stones (LECS) were deposited in CL 3, where flooding muds predominated at about 126 m a.s.l. (grid 5C). Charcoals obtained from the same horizon of grid 5C (126.057 m a.s.l.) produced two radiocarbon ages: 34,020 ± 400 BP (OTg141001, KIGAM-2014) and 36,600 ± 1100 BP (AA105103, UA-2014). The average calibrated (2σ) age is 38,046–35,681 cal BP and 40,536–37,281 cal BP (Kim K.J. et al., 2021). The discovery of LECS in CL 3 (Fig. 9) suggests that modern humans who lived during the Early Upper Paleolithic might have had some metrological cognition to reproduce blade tools and LECS (Fig. 10). In addition, it can be inferred that CL 2 was formed in the Late Upper Paleolithic under severe paleoclimate conditions (events 2.2–2.21, after (Pisias et al., 1984)), while CL 3 and 4 in the Early Upper Paleolithic under relatively mild interstadial paleoclimate conditions (event 3.1, after (Ibid.)).

## Discussion

### *Morpho-stratigraphical and sedimentary environments*

The Namhan River Valley in Danyang County was excessively denudated. Correspondingly, the base level of old riverbeds might have been conspicuously lowered, at least to 115 m a.s.l. The average altitude difference between the gravel beds of the third FT and the present riverbeds in Suyanggae Loc. III is about 45 m. Accordingly, the geomorphic formation age of the middle fluvial terrace can be calculated to as old as ca 300 thousand years, if we apply a general uplift rate amounting to ca 0.14–0.15 m/thous. years; this rate is one of the lowest in the Korean Peninsula (Kim J.Y. et al., 2008). Morpho-stratigraphically, Suyanggae Loc. VI was developed above the second FT, but Suyanggae Loc. III is situated above the third FT, at least 25 m higher than the second FT (see Fig. 2). The second fluvial terrace, as shown in Suyanggae Loc. I and VI, is much younger than the third fluvial

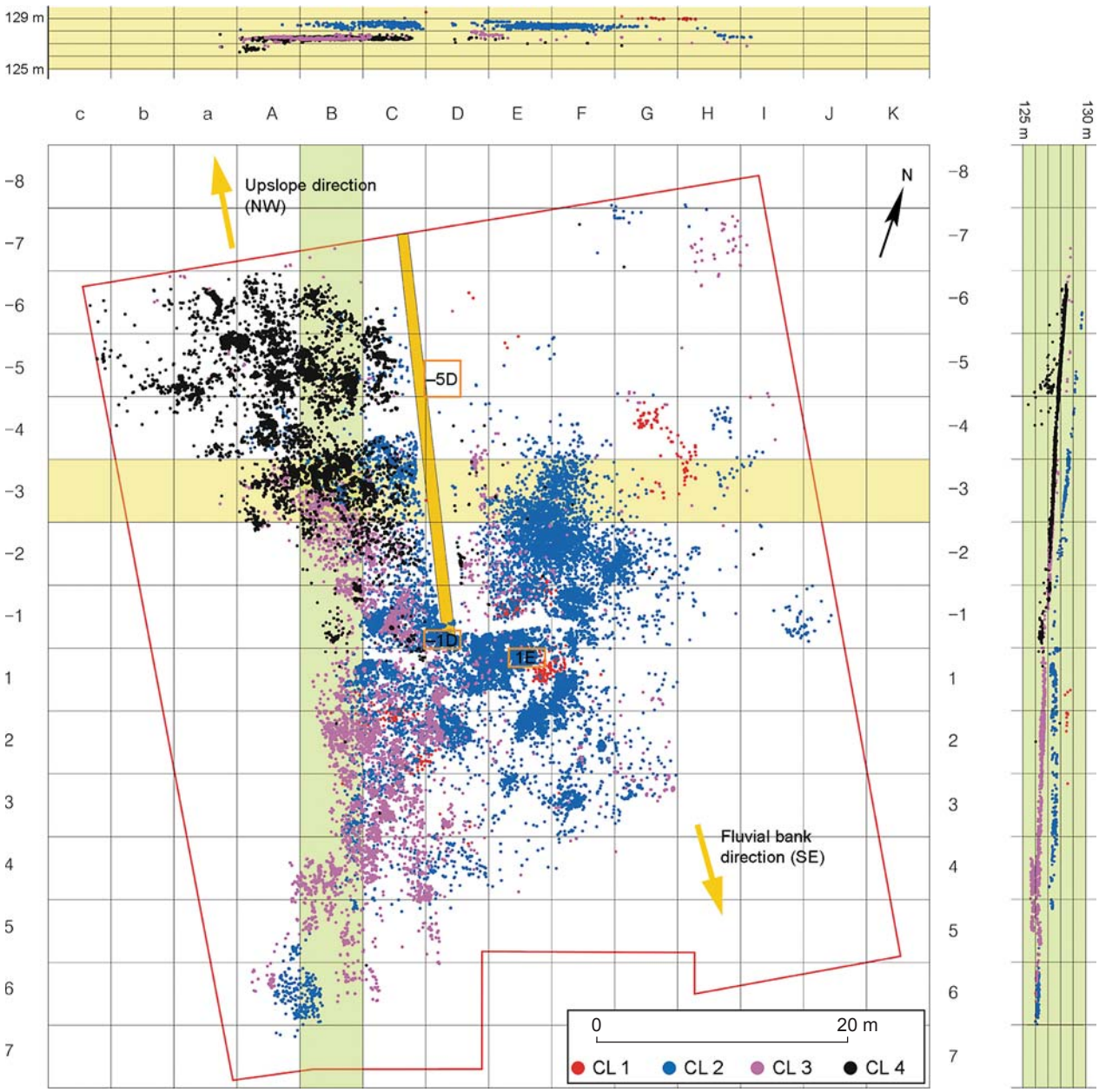


*Fig. 5.* Vertical and lateral distribution of CL 1–4 in the excavation grids of Suyanggae Loc. VI.

**Radiocarbon dates obtained from charcoals from CL 2–4 in Suyanggae Loc. VI**

| Cultural layer | Sample | Grid | $^{14}$C-age, BP | Calibrated age, ± 2σ (95.4 %) | AMS facility |
|---|---|---|---|---|---|
| 2 | SYG-2-1 | 3F | 18,400 ± 60 | 22,454 ~ 22,028 | IAAA |
| | SYG-2-2 | 1Tr | 17,779 ± 85 | 21,826 ~ 21,242 | NSF |
| | | | 17,660 ± 90 | 21,677 ~ 21,034 | CAL |
| | SYG-2-3 | 1C | 20,470 ± 70 | 24,962 ~ 24,344 | IAAA |
| | SYG-2-4 | 2C | 18,770 ± 60 | 22,846 ~ 22,442 | IAAA |
| | | | 18,690 ± 60 | 22,732 ~ 22.391 | IAAA |
| | | | 17,850 ± 60 | 21,850 ~ 21,411 | IAAA |
| | | | 17,550 ± 80 | 21,493 ~ 20,927 | KIGAM |
| | | | 18,490 ± 80 | 22,557 ~ 22,141 | KIGAM |
| 3 | SYG-3-1 | -3C | 34,880 ± 190 | 39,916 ~ 38,875 | IAAA |
| | SYG-3-2 | -1E | 32,450 ± 160 | 36,773 ~35,952 | IAAA |
| | SYG-3-3 | -1B | 36,280 ± 200 | 41,417 ~ 40,418 | IAAA |
| | SYG-3-4 | 1D | 34,690 ± 180 | 39,696 ~ 38,721 | IAAA |
| | SYG-3-5 | 2E | 38,180 ± 230 | 42,705 ~ 41,996 | IAAA |
| | | | 39,680 ± 390 | 44,163 ~ 42,755 | CAL |
| | SYG-3-6 | 3C | 30,360 ± 350 | 34,976 ~ 33,804 | NSF |
| | SYG-3-7 | 3C | 35,280 ± 470 | 40,965 ~ 38,821 | CAL |
| | SYG-3-8 | 5C | 36,000 ± 1,100 | 42,549 ~ 38,571 | NSF |
| | | | 34,020 ± 400 | 39,549 ~ 37,283 | CAL |
| 4 | SYG-4-1 | -3B | 36,580 ± 210 | 41,678 ~ 40,726 | IAAA |
| | SYG-4-2 | -3B | 34,620 ± 190 | 39,641 ~ 38,651 | IAAA |
| | SYG-4-3 | -3C | 42,000 ± 340 | 46,008 ~ 44,722 | IAAA |
| | SYG-4-4 | -6A | 36,600 ± 360 | 41,871 ~ 40,473 | CAL |
| | SYG-4-5 | -5B | 37,190 ± 320 | 42,201 ~ 41,186 | CAL |
| | SYG-4-6 | -4B | 34,870 ± 540 | 40,724 ~ 38,397 | CAL |

*Note*: AMS-dating was carried out in the Korea Institute of Geoscience and Mineral Resources (KIGAM), Carbon Analysis Laboratory, Korea (CAL), Institute of Accelerator Analysis, Japan (IAAA), and Arizona AMS Laboratory, USA (NSF).

terrace. The sedimentary deposits are typified by fluvial sand and gravel, slope deposits, such as mud and debris flow, and paleosols—the main lithological units constituting the site-formation materials of Suyanggae Loc. VI. On the basis of the representative profile of Suyanggae Loc. VI, dominant sedimentary deposits are composed of sands and gravel at the bottom, sands and flooding muds with occasional intercalations of reddish-brown slope mud flows, and debris flows comprising subrounded to subangular cobbles or boulders.

### *Paleosols as pedosedimentary units*

In the Korean Peninsula, paleosols formed during or after the last interglacial period (ca 130 ka BP) are widely observed in the eroded parts of slope margins or above fluvial terrace gravels (Lee D.Y., Kim, 1992; Kim J.Y., Lee, 2006; Kim J.Y., Lee, Choi, 1998; Kim J.Y., Yang, 2001, Kim J.Y. et al., 2016, 2017; Kim J.Y., 2001). Suyanggae sites are one of the most well-known fluvial open sites on the Peninsula. They are characterized by paleosols defined as pedo-


*Fig. 6.* Main artifacts from CL 2 in Suyanggae Loc. VI.
*1* – cores; *2* – blade cores; *3* – micro-blade cores; *4* – flakes; *5* – blades; *6* – spalls; *7* – hammer stones; *8* – side-scrapers; *9* – end-scrapers; *10* – burins and points; *11* – fragments of a stone-bowl.

sedimentary units. These overlie sand and gravel derived from the fluvial process of the paleo-Namhan River (see Fig. 3, 4). Lithic artifacts are not found directly on fluvial sand and gravel; they occur in typical paleosols. Correspondingly, artifact-bearing layers can be considered as soil sedimentary units. In Suyanggae Loc. VI, paleosols can be categorized into dark-brown (Pdb), brown (Pb), yellowish-brown (Pyb), and reddish-brown (Prb). Pb and Pdb are characterized by relatively rich goethite as iron hydroxides, generally showing polygonal patterns and low magnetic susceptibility. In Pb or Pdb, Upper Paleolithic flakes and (micro)blades were found. As observed in Suyanggae Loc. VI, which contains hematites, Prb shows a silt-dominant trend with increasing magnetic susceptibility. Hence, Prb is formed by oxidation during the surficial or overland flow process. Geomorphologically, Prb prevails in the slope margin, ranging from the slope summit through the backslope to the foot slope. Some large lithic artifacts are also associated with Prb in Suyanggae Loc. III. Prb and Pb above the second FT are regarded to have formed during the early to middle part of the last glacial period. The oldest Prb was formed between approximately 45 and 60 ka BP (Kim J.Y. et al., 2016; Kim J.Y., Lee, 2005, 2006). However, Pb was formed as late as about 30 ka BP. At Suyanggae Loc. I, the fluvial deposits at the foot slope were dated to the


*Fig. 7.* Main artifacts from CL 3 in Suyanggae Loc. VI.
*1* – cores; *2* – blade cores; *3* – blades; *4* – flakes; *5* – hammer stones; *6* – refitted artifacts; *7* – side-scrapers; *8* – tanged-points; *9* – line-engraved cobble stone.

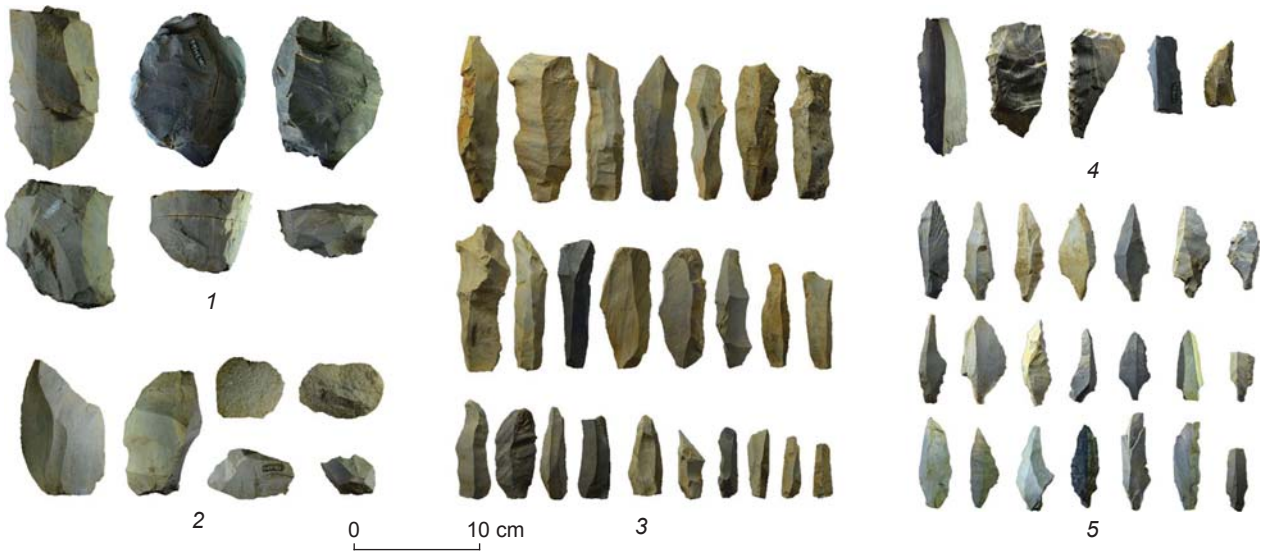


*Fig. 8.* Main artifacts from CL 4 in Suyanggae Loc. VI.
*1* – cores; *2* – flakes; *3* – blades; *4* – side-scrapers; *5* – tanged-points.

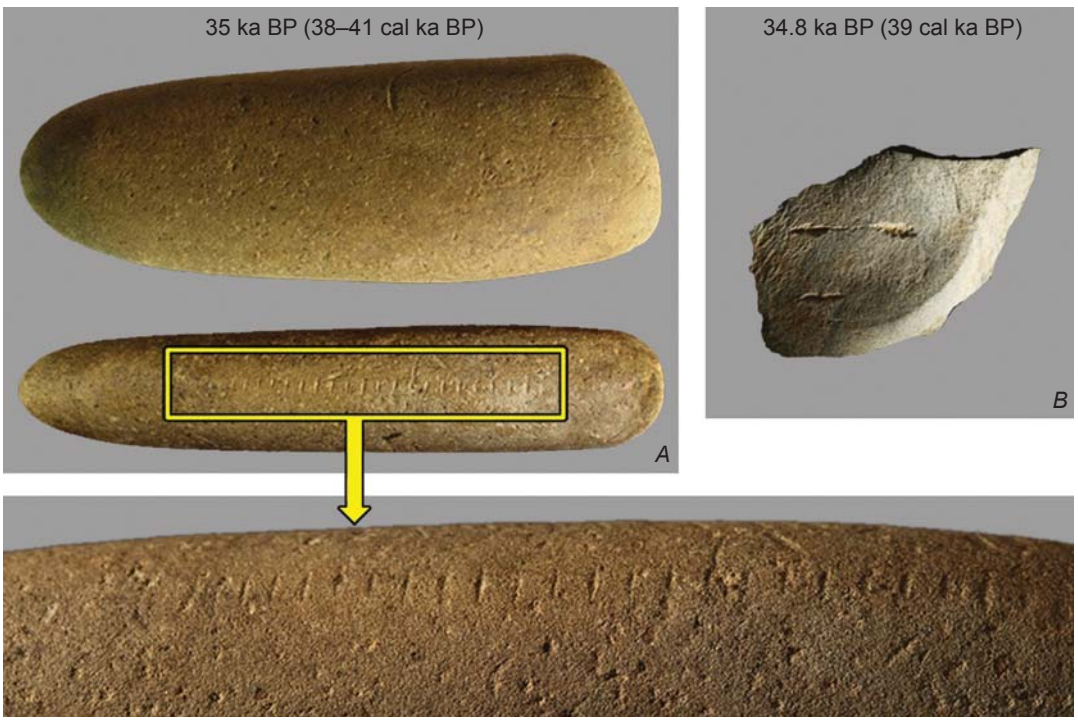


*Fig. 9.* Line-engraved cobble stone (*A*) and face-engraved pebble stone (*B*) from Suyanggae Loc. VI.

range from 28,630 ± 190 BP to approximately 31,140 ± ± 280 BP, so the cultural layer in the Pb matrix over the second FT may be regarded as the late middle last glacial period. Finally, the age of the Pdb in Suyanggae Loc. I is about 18 ka; this may be interpreted as the typical paleosol of the LGM (see Fig. 10).

### *Artifact assemblage*

Lithic artifacts discovered during successive excavation surveys in Suyanggae Loc. VI, included flakes, blades, and tanged points. Many small flakes, cores, blades, scrapers, and points were deposited in

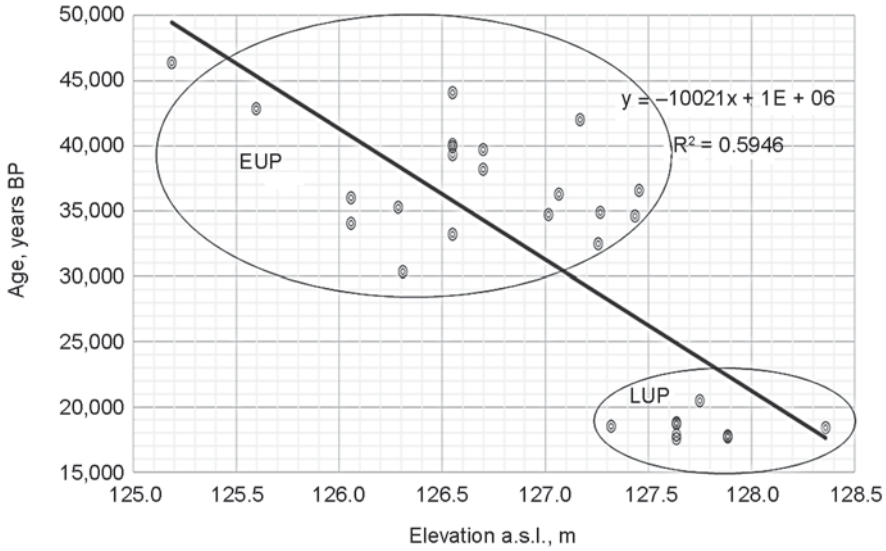


*Fig. 10.* Chronology of cultural layers showing the Late Upper Paleolithic (CL 2) and the Early Upper Paleolithic (CL 3 and 4) at Suyanggae Loc. VI.

Pdb, Pb, Pyb, and Prb. Artifacts are made from raw materials such as quartzite, quartz dykes, sandstones, rhyolites, hornblende, and so forth. At Suyanggae Loc. VI, most of artifacts (blades, scrapers, tanged points, microliths, and face-engraved pebble stones (FEPS)) (see Fig. 6, 7), as well as tool-making debitage, were found in CL 2 and 3. The lithic assemblage of Suyanggae Loc. VI CL 2 contains abundant microblades (see Fig. 6), while those of CL 3 and 4 tanged points and blades (see. Fig. 7, 8). Furthermore, in CL 3, in the sediments of flooding mud on the second FT of the paleo-Namhan River, below 127 m a.s.l., a line-engraved cobble stone was found (see Fig. 9). At Suyanggae Loc. VI, the chronology of CL 3, associated with tanged points and blades, ranges between 36 and 42 ka BP, and the age of lithic artifacts of CL 2, characterized by abundant microblades, converges to ca 20 ka BP (LGM) (see *Table*). Therefore, it makes sense that CL 2–4 at Suyanggae Loc. VI belong to the Early to Late Upper Paleolithic, with a predominance of blades and tanged points (see Fig. 6–8, 10).

## Conclusions

The site of Suyanggae Loc. VI is situated above the second fluvial terrace, which is below the middle fluvial terrace (third FT). The second FT generally prevails at the topographical level of the fluvial sand and gravel lower than about 130 m a.s.l., along the slope margins of the Namhan River valley. The main components of surficial deposits of Suyanggae Loc. VI are pedosedimentary units of fluvial deposits, slope deposits, and paleosols. The surficial deposits comprise sands and gravel at the bottom, sands and flooding muds with occasional intercalations of reddish brown slope muds, and rounded or subangular cobbles or boulders between the middle and upper parts of the representative profiles of Suyanggae Loc. VI. According to the results of the analysis of sedimentary site-formation processes and the chronological data, Suyanggae Loc. VI was formed after the middle last glacial period (ca 45 ka BP (Martinson et al., 1987)). Myriad radiocarbon datings for the charcoals collected from the excavations in Suyanggae Loc. VI suggest that CL 2 was formed in the Late Upper Paleolithic and CL 3 in the Early Upper Paleolithic. This is also supported by the dates of CL 2 of Loc. VI, which can be correlated with those of CL 1 of Loc. I, converging with the Late Upper Paleolithic culture, approximated to the LGM. The Late Upper Paleolithic culture is stratigraphically better established in Loc. VI than in Loc. III or I. The lithic artifact assemblage of Loc. VI CL 2 is characterized by abundant microblades (18–19 ka BP, post-LGM), while those of CL 3 and 4 by blades and tanged points, respectively, dating to ca 36–42 ka BP, before the LGM (see *Table*; Fig. 10).

Importantly, in the lower limit of the sedimentary matrix of fluvial origin, a line-engraved cobble stone (LECS) was found, and in the upper part of flooding muds, where the slope mudflow was gradually influenced by the sedimentary matrix, a face-engraved pebble stone (FEPS) was discovered. The radiocarbon ages of the LECS averaged 39,500 cal BP, ranging between 38,000 and 41,000 cal BP. On the basis of these estimates, it can be suggested that at Suyanggae Loc. VI, the earliest evidence of metric knowledge and symbolic behavior of the Early Upper Paleolithic humans in the territory of Korea were discovered. Finally, the 395 tiny holes distributed at the surface of LECS may be associated with observations of stars.

## Acknowledgements

This study was supported by the Korea Institute of Geoscience and Mineral Resources (KIGAM) and greatly indebted to the research collaboration with the Institute of Korean Prehistory (IKP). The authors express great gratitude to the IKP for the elaboration on preparing this paper and for a series of interdisciplinary workshops regarding the geoarchaeological context of Suyanggae.

## References

**Kim J.Y. 2001**
Quaternary geology and assessment of aggregate resources of Korea for the national industrial resources exploration and development. *Quaternary International*, vol. 82 (1): 87–100.

**Kim J.Y., Lee D.Y., Choi S.G. 1998**
A research on Pleistocene stratigraphy. *The Korean Journal of Quaternary Research*, vol. 12 (1): 77–88.

**Kim J.Y., Lee K.W., Suh H.S., Choi W.H., Yang H.J., Kim K.J., Woo J.Y., Lee Y.J. 2017**
Sedimentary matrix-forming process of the engraved stone-bearing Suyanggae Site (LOC. 6) of the Upper Paleolithic, Danyang County, Korea (S1-3-R03). In *Conference Abstract Book of the 3rd Asian Association for Quaternary Research*. URL: www.asqua2017.org

**Kim J.Y, Lee Y.J. 2005**
Morpho-stratigraphy and pedo-sedimentological formations of the Suyanggae site of the Namhan River, Danyang County, Korea. In *Proceedings of the 10th Intern. Symp.: Suyanggae and Her Neighbours*. Cheongju: Chungbuk National Univ. Museum and Inst. of Korean Prehistory, pp. 43–56.

**Kim J.Y., Lee Y.J. 2006**
Stratigraphy of the Upper Pleistocene and Paleolithic in Korea. *L'anthropologie*, vol. 110 (2): 119–138.

**Kim J.Y., Oh K.Ch., Yang D.Y., Choi W.H., Hong S.S., Lee Y.J. 2008**
Stratigraphy, chronology, and implied uplift rate of coastal terraces in the southeastern part of Korea. *Quaternary International*, vol. 183 (1): 76–82.

**Kim J.Y., Suh H.S., Oh K.Ch., Lee S.W. 2020**
Geoarcheology and Quaternary formation of Suyanggae sites in Danyang County of Korea. *Journal of Museum Studies*, vol. 39: 53–82.

**Kim J.Y., Yang D.Y., Hong S.S., Yi S., Nahm W.H., Lee J.Y. 2016**
Stratigraphic perspective of the Late Pleistocene terrace geomorphology and geosols in the Keum River Basin of Korea. In *Abstract Book of the Autumn Conf. of the Geol. Soc. of Korea*. [s.l.], p. 59.

**Kim J.Y., Yang D.Y. 2001**
Geomorphology and geology of Palaeolithic sites of Korea. In *Palaeolithic Culture of Korea*. Seoul: Yonsei Press. (Museum of Yonsei Univ. Academia; [No. 1]).

**Kim K.J., Kim J.Y., Lee K.W., Lee S.W., Woo J.Y., Lee Y.J., Timothy Jull A.J. 2021**
Radiocarbon ages of Suyanggae Paleolithic sites in Danyang, Korea. *Radiocarbon*, vol. 63 (5): 1429–1444.

**Lee D.Y., Kim J.Y. 1992**
Review on the Quaternary stratigraphy of the Korean Peninsula. In *Sino–Korean Symposium of Quaternary and Prehistory*. [s.l.], pp. 69–99.

**Lee Y.J. 1989**
Report on the upper Paleolithic culture of Suyanggae site, Korea. In *Abstracts of the 1st World Summit Conference on the Peopling of the Americas*. Orono: Center for the Study of the First Americans, p. 40.

**Lee Y.J. 2000a**
Suyanggae microblade core industry in Korea. In *Abstracts of the INQUA XV International Congress: The Environmental Background to Hominid Evolution in Africa (3–11 August 1999, Durban, South Africa)*. Oxford, Tarrytown: Pergamon: Elsevier, p. 20.

**Lee Y.J. 2000b**
Role and significance of the Suyanggae culture in East Asia. In *Abstracts of the 2nd Worldwide SEAA Conference (6–9 July 2000, University of Durham, England). Society for East Asian Archaeol*. [s.l.], p. 20. URL: https://seaa-web.org/conferences/past/durham-2000/abstracts-a-m#L

**Lee Y.J. 2007**
Suyanggae: Why so important? In *The 12th Intern. Symp. Suyanggae and Her Neighbours: Prehistoric Migrations in Eurasia and America*. Krasnoyarsk, Cheongju: Krasnoyarsk State Pedagogical Univ. named after V.P. Astafiev; Inst. of Korean Prehistory, pp. 7–23.

**Lee Y.J., Kong S. 2004**
Spatial distribution analysis of Suyanggae Site, Korea. In *The Intern. Symp. of Paleoanthropol. in Commemoration of the 100th Anniversary of the Birth of Prof. Pei Wenzhong and the 75th Anniversary of the Discovery of the First Peking Man Skull*. Beijing: Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, p. 10.

**Lee Y.J., Woo J.Y., Kong S. 1999**
Suyanggae tanged point in Korea. In *The Intern. Symp. on Paleoanthropol. in Commemoration of the 70th Anniversary of the Discovery of the First Skull of Peking Man*. Beijing: Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, p. 14.

**Lee Y.J., Woo J.Y., Lee S.W., Ahn J.H., So D.Y., Shin S.Ch., Noh H.S. 2013a**

Progress report of the Suyanggae Site Loc. III, Danyang – 2011 Year Excavation (10th). In *IKP Research Report*, vol. 40. Cheongju: Inst. of Korea Prehistory, p. 255.

**Lee Y.J., Woo J.Y., Lee S.W., Ahn J.H., Yun B.I., Park J.M., Otani K., Kim M.R., Kim E.J., Han S.Ch., Jang H.I., Choi D.H. 2018**

Report on the excavation of the Suyanggae Site (Loc. I and VI), Danyang. In *IKP Research Report*, vol. 90. Cheongju: Inst. of Korea Prehistory, p. 827.

**Lee Y.J., Woo J.Y., Lee S.W., Kang M.K., Yun B.I., Otani K., Kim M.R. 2013b**

Progress report of Suyanggae site Loc. III, Danyang – 2008 Year Excavation (9th). In *IKP Research Report*, vol. 39. Cheongju: Inst. of Korea Prehistory, p. 149.

**Lee Y.J., Yoon Y.H. 1992**

Micro-blade cores from Suyanggae Site, Korea. In *The Intern. Symp. on the Chronostratigraphy of North, Central, East Asia, and America*. Novosibirsk: Inst. of Archaeology and Ethnography SB RAS, pp. 135–146.

**Lee Y.J., Yoon Y.H. 1993**

Tanged-Point and Micro-Blade Core from Suyanggae Site, Korea. The Origin and Dispersal of Microblade Industry in Northern Eurasia. Sapporo: Sapporo Univ., pp. 52–69.

**Martinson D.G., Pisias N.G., Hays J.D., Imbrie J., Moore T.C., Shackleton N.J. 1987**

Age dating and the orbital theory of the ice ages: Development of a high-resolution 0 to 300,000-year chronostratigraphy. *Quaternary Research*, vol. 27 (1): 1–29.

**Oh K.C., Kim J.Y. 2018**

Formation and environment of Quaternary deposits of Suyanggae Loc. 1 and VI in Danyang County. In *IKP Report on the excavation of the Suyanggae Site (Locs. VI and I), Danyang. IKP Research Report*, vol. 90 (Addendum). Cheongju: Inst. of Korea Prehist., pp. 5–93.

**Pisias N.G., Martinson D.G., Moore Jr. T.C., Shackleton N.J., Prell W., Hays J., Boden G. 1984**

High resolution stratigraphic correlation of benthic oxygen isotopic records spanning the last 300,000 years. *Marine Geology*, vol. 56 (1–4): 119–136.

*Received March 10, 2023.*
*Received in revised form May 25, 2023.*