GIS Research of the Ancient Cemeteries in the Silla and Gaya Regions, Korea

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INTRODUCTION

In this paper we analyze the spatial organization of burials in the ancient cemeteries of Silla and Gaya society in Southeast Korea using GIS (geographical information systems) techniques. As an archaeological record, a cemetery is a group of burials that result from the sequential constructions of graves within a limited area. It necessarily follows that one or more social groups continuously constructed burials. It has therefore been assumed that each grave in a cemetery contains direct information related to the age, gender, status and occupation of individuals and the distributional feature of it represents the organizational and structural configurations of the social group (Goldstein 1976, 1981; Kim 2001; O'Shea 1981, 1984; Peebles and Kus 1977; Randsborg 1973).

A large number of cemeteries were constructed in Silla and Gaya region in a dense and clustered manner during the Proto-Three Kingdom and Three Kingdom period. A diverse range of typological patterns characterizes the cemeteries of this period. In a few cases, a large number of burials had been concentrated in a geographically limited area over several hundred years. Some cemeteries could be characterized as having formed over a long-term process in a vast area, but others were formed within a few decades. In the cemeteries including the graves of an elite group, they are highly differentiated in the amount of grave goods, the scale of burial structure, and the deposition in the landscape from the other members. Yet in the cemetery of common social group, however, the remarkable evidence of ranking in the wealth and the effort-expenditure for the interment ritual could not be detected.

Through the history of archaeological mortuary research, Korean archaeologists have analyzed the burial data of Silla and Gaya in order to create a regional chronology or to produce cultural historical studies (Choi 1992; Kim 1985; Lee 1982). From the early 1990s, the direction and the environment of Korean archaeology dramatically changed. Especially, financial and institutional improvements for the rescue excavations permit the archaeologists to acquire the large amount of burial data. As a typical example, Yimdang-dong site, an extensive cemetery in which the graves of the elite group of the local polity in the Gyeongsan basin were concentrated, have been almost completely excavated over a decade due to housing construction. Recently, the aim of mortuary study has gradually turned to the reconstruction of ancient social organization based on the increased data.

Among the various observable dimensions of the Silla and Gaya burial data, our analyses focus on the spatial organization of individual graves in the cemetery. In the case of long-term formation process, the graves of later period were construction on top of the former layer, and because so many are concentrated in a limited area, it is difficult to determine the distributional patterns that are significant in each period. We posit that GIS techniques are a very effective tool for describing the meaning inherent in burial arrangements or clustering and to predict the explanatory regularity in them. This paper is a pilot study and contains a tentative approach to discriminate spatial patterning and regularity in the burial distribution over the long and short term using GIS techniques.

HISTORICAL BACKGROUND

1. Proto-Three Kingdoms (100 BC-AD 300) and Three Kingdoms Period (AD 300-676) of Silla and Gaya Society

Located in the South-east of Korean peninsula, the Youngnam (嶺南) region was occupied by the twin political systems, Silla (新羅) and Gaya (加耶), during the Three Kingdoms Period (三国時代). Until the 3rd century AD, 24 individual small polities of which names were recorded as "XX-Guk (国)" were distributed in Youngnam area. Ancient Chinese historians classified them into two groups, Jin-Han (辰韓) and Byeon-Han (弁韓), and described them as small polities ruled by the chiefs who controlled the socio-political system organized with several thousand households. Silla and Gaya had grown out of Jin, Byeon-Han system. The very name of Silla comes from Saro-Guk (斯廬国), a polity that occupied the Gyeongju (慶州) Basin as a member of Jin-Han group, and Gaya was originally designated as the polity Guya-Guk (狗邪国), located at the coastal area of ancient Gimhae Bay. The Silla and Gaya system culminated in extreme confrontation between the two groups in the 6th century AD. Both originally resulted from hierarchization and reorganization processes of the power distributions between Jin- and Byeon-Han polities.

Saro-Guk was not powerful enough to exercise political influence on the neighbouring polities until the 3rd century AD. Although until the 4th century AD Silla did not achieve the fully centralized political system, from 5th century AD the early state government of Gyeongju was able to control surrounding polities such as Apdok-Guk in Gyeongsan, Sabeol-Guk in Sangju, Somun-Guk in Euseong, among others. Additionally, the strong centralized government of Silla appeared in the northern and eastern part of the Nakdong-River valley during the early 6th century AD.

2. The Transformation of Silla and Gaya Society and Burials

Compared with the socio-political development of Silla state, Gaya has been

conceptualized as a group of polities or as a confederacy distributed within a geographical landscape. Although historian and archaeologists have different ideas about the scale and the internal organization of Gaya and the nature of confederacy itself, general assumptions regarding the Gaya confederacy have been widely accepted.

In the Proto-Three Kingdoms Period, Goguryeo (高句麗) was emerging as an ancient state in the Aprok River valley, the three Han (韓), Mahan (馬韓), Jin-Han (辰韓) and Byeon-Han (弁韓), as three minor groups, grew larger through competition in the southern part of Korean Peninsula. Although the three ancient kingdoms, namely Goguryeo, Baekje and Silla, were already established, they were just small polities no larger than competitive neighbouring polities yet. Accordingly, the phase that comes before the full-blown kingdoms is referred to as the Proto-Three Kingdoms Period, because three kingdoms did not yet developed into the fully centralized states.

In the Jin-Han and Byeon-Han regions, wooden coffin pit-burials came to be grouped together into the cemetery from the 1st century BC. Among the well-known cemetery sites of this period, such as Daho-ri in Changwon, Paldal-dong in Daegu, and Choyang-dong in Gyeongju, the grave type that was used was the wooden coffin pit-burial in which several elite were interred. Such burials lacked a large-scale mound. The elite burials of the early phase (from BC 1st century to AD 2nd century) of Proto-Three Kingdom Period have wealth objects that are totally absent in other commoner's burials, such as the bronze ornaments and weapon and the exotic goods from Lelang (楽浪), an outpost the Western Han (漢) of Chinese civilization. Yet in the linear arrangements of burials of the cemeteries belonging to this phase, the elite burials neither occupy a special position, nor create a significant clustering.

From 3rd century AD elite grave goods, which symbolized the wealth and power of political leaders, were increasing in large quantities. To construct the expanded structure of elite graves, the Lelang style wooden chamber burial came to be adopted. Then the cemeteries of the elite groups burials came to be arranged so that they centred on the highest-ranked burial. Under this scheme elite graves with large chambers were built in prominent locations on a given landscape. Topographically, the top of an elongated hill was carefully selected and the burials of elite group were linearly disposed along the ridgeline of the hill. At first glance, it is evident that the dispositions of elites be followed by the lower rank burials. They might be distributed at certain distance from the position of elite graves.

In early 5th century AD, Silla began to extend its political influence and control the north and east regions of the Nakdong River (洛東江) Valley. The western region, however, was divided into three major Gaya polities - Daegaya of Goryeong, Aragaya of Haman, Sogaya of Goseong. Although these three polities were confederated against Silla from the beginning of 6th century, they failed to form an integrated and centralized state as did Silla.
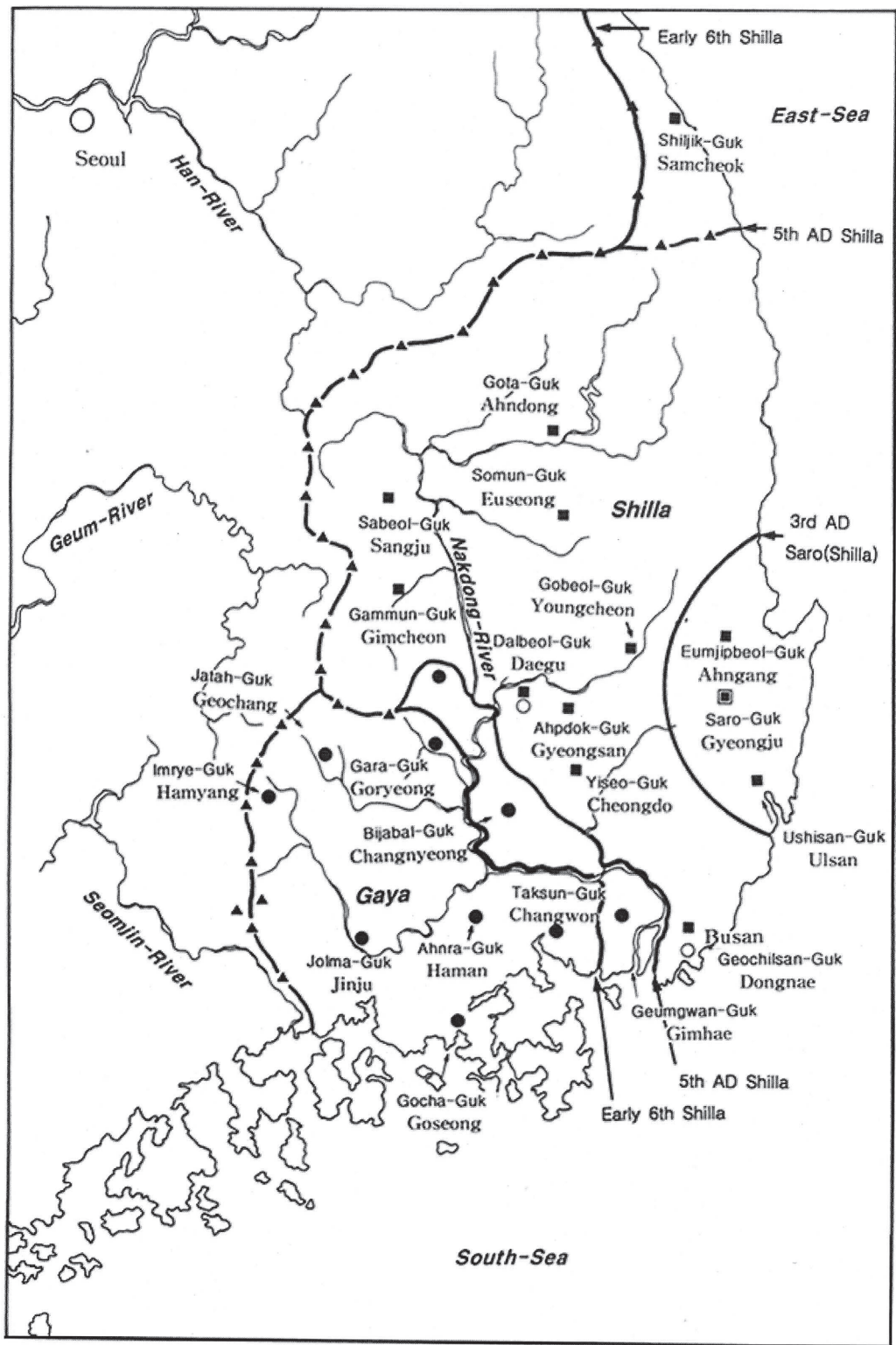
Fig.1 Division of Silla and Gaya and formation of centralized state of Silla

In the late 6th century, Silla annexed Gaya and incorporated the whole Nakdong River Valley into its centralized state system. During 3rd and 4th centuries, the inner structure of burials, from the royal tombs to the lowest ranked graves, was a wooden chamber. In 5th century this mortuary form was gradually replaced by the stone chamber and stone-piled wooden chamber type. Notably, the stone-piled wooden chamber tombs were covered with a massive tumulus and were exclusively constructed for the kings and aristocratic members of Silla.

The corridor type stone chamber that became popular in the whole Silla and Gaya area from 6th century was adopted for a number of interments over time. Archaeologists have suggested that individuals that were buried in the same chamber should be connected, within a prescribed distance, by family or kinship ties. It was, however, a half century earlier than the adoption of the corridor type stone chamber when local communities represented kin or family relationship in the distributional patterning of the burials. As for the social dimension of mortuary behaviour, the temporal variation of burial type is never as important as that of distributional patterning.

In the overall transformation of the Silla and Gaya cemeteries, the burial distribution patterning was significantly altered twice in the Proto-Three Kingdoms and Three Kingdoms (Lee 1998). The first occurred in the early 3rd century and is regarded as the beginning of the royal cemetery formation process that continued for about 400 years. The second event took place, not at the upper rank of elite burials, but in the clusters of small graves in the lower class cemeteries, during the 5th century. According to the arguments of ancient historians based on the interpretation of historical documents, Silla and Gaya experienced sweeping social changes during the emergence of the centralized state. Relatively independent local polities and their sub-groups should be socially differentiated and reorganized. Especially, under the direct control of central government, the social organizations of local communities were rapidly changed. So I have suggested that the second change of grave distribution patterning should be related to the social transformation of the local social groups.

MORTUARY STUDIES IN SILLA AND GAYA ARCHAEOLOGY

Archaeologists are more interested in analyzing the entire cemetery, rather than just a single burial. They acknowledge that it is more effective data for which to establish the regional chronology. Generally, the cemetery has two distinctive features that fascinate cultural historians, esp. 19th century Scandinavian archaeologists (Klindt-Jensen 1975). One is related to the nature of its formation process. In most cases, a cemetery grows in certain direction, because individual graves are added one by one in a sequential manner. If the archaeologist recognizes the direction and starting point, s/he could simply arrange the burials in temporal order. Another feature is the deliberate and simultaneous interments of

artefacts in a single grave. Assemblages of grave goods have been labelled as 'closed finds', since artefacts were buried together with individuals simultaneously, in a single event. This distinctive interment makes it effective to compare the one of the grave good assemblages with the other, and easy to define the chronological sequence.

Although Silla and Gaya archaeologists recognize the importance of cemetery data, because they think that their first aim is to establish the chronology of Silla and Gaya material culture, they are more interested in the specific class of artefacts discovered from individual graves, for example pottery, gold and silver ornaments, horse trappings and so on, than the grouping of burials. Until recently, they have rarely analyzed variables in a systematic way, such as the location in the landscapes, the hierarchy of mortuary practice, spatial patterning of grave distribution, and the treatment and deposition of individuals. Their works have only described the material culture history based on typological analyses of artefacts. From early 1990s, several archaeologists have focused their analyses on the distributional features of cemeteries at the regional level to reconstruct the scale and internal organization of Silla and Gaya polities (Choi 1991; Kim 1989; Lee 1993, 1998; Lee 1998, 2000; Park 2000). What makes it possible to overcome the limitation of the traditional assumptions and analyses in mortuary research is the improved data set provided by the constitutionally supported rescue excavations and intensive archaeological surveys.

When we explore the cemetery data to understand the ancient sociality, we cannot but assume the existence of one, or more than one social groups were buried there. If a large number of graves are concentrated on the limited area, there must be a sedentary social group(s). And if, in a region, a number of cemeteries belonging to same period are distributed hierarchically or in other manner, there a certain number of communities that maintain the hierarchical or other relationship with each other must be distributed. It seems, therefore, reasonable to suggest that the distribution of graves and the cemeteries should be very effective data to make inference about the scale and organization of social groups and their relationship. In the analyzing of mortuary data with relevance to reconstructing the scale and organization of ancient societies, the distinction of the two different observational dimensions, the intra-cemetery and the inter-cemeteries, is required (Lee 1998). The Silla and Gaya archaeologists are well recognized the nature of the mortuary data.

Silla and Gaya society had been composed of relatively independent polities until the centralized government of Silla emerged about 6th century AD. During the Proto-Three Kingdom and Three Kingdom Period, on the one hand the self-integration and the social complexity of each polity were gradually increased, and the interaction networks in certain cluster of polities developed ultimately into the centralized political system on the other. The Silla and Gaya archaeologists have placed an more emphasis on the inter-cemetery

analyses, because they have been more interested in inferring about the scale and internal organization of the local polities and their various networking before the advent of the centralized state (Lee 1998, 2000; Park 2000). Therefore, they have neglected intra-cemetery analysis techniques that can shed light on the spatial organization of burials in a given period, the features of long-term growth in the cemetery, and the hierarchical patterning related to the various aspects of the burials. This micro-level analysis must be emphasized as a relevant approach to understand the social organization and dynamics of local groups (Brown 1981; Goldstein 1976, 1981; Saxe 1970, 1971).

The post-war Marxist archaeologists of Japan clearly show the emergence of the political elite, the king, from the social group and consider power and the process of ranking among competitive social groups (Kondo 1983; Takakura 1973). They have done this through detailed analyses at the intra-cemetery level. The cemeteries of Yayoi period are relevant data to approach to ancient social groups and their dynamics through the intra-site analysis. In the Silla and Gaya region, a large number of cemeteries from various periods, show clear patterns of growth, internal hierarchy, and are densely distributed over the landscape. Therefore, it is expected that a detailed intra-site analysis of Silla and Gaya burials would be very productive approach to understanding cultural change in ancient society.

REPRESENTING CEMETERY GROWTH WITH GIS

1. Spatial and Social Organization

Burial data are viewed as critical elements of the archaeological record because they were not left by processes of unconscious discard or abandonment, but by symbolic and socially meaningful behaviour. Thus archaeologists are interested in ancient cemeteries because social configurations of the ancient group are manifested in them. In the archaeological approaches to the Silla and Gaya societies the burial data have played important roles, because they left a great number of cemeteries everywhere in their territory.

The Silla and Gaya archaeologists have classified the cemeteries into the several types, analyzing the attributes like a social ranking of the members, a time span or a period of forming process, a density and distributional patterning of the graves, and so on (Hong 2003; Lee 1993, 1998). Among them, the archaeologists whose research goal is the reconstruction of the past social organization lay an emphasis on the spatial organizations of cemeteries (Goldstein 1976, 1981). It is admitted that those are reflections of organizational principles of the society, because the mortuary practices are correlated with the organization of the past society. In the Silla and Gaya cemeteries, it is expected that the analyses of the distributional patterning of graves could yield significant information of the various social groups.

Generally, Silla and Gaya cemeteries formed over several hundred years. In some sites,

thousands of graves were concentrated on the area prepared for a cemetery. As time passed, the space of a cemetery increased and its distributional feature became complicated, in short it was evolved. Conceptually, the cemetery evolution processes could be classified into two types. In the first case, if so many graves are accumulated within limited area during hundreds years, the cemetery expand its territory. In the second, the earlier graves become overlaid by the later ones because of reoccupation of same space after a few hundreds years. If the cemetery expands several direction or so many graves are concentrated on the limited area, it cannot be possible to discriminate the significant spatial organization in relatively short period. In any case, it is nearly impossible to make observation itself of the social dimensions in the distribution of burials as the result from the long-term accumulation of graves in great number.

2. Data and Software

It is relatively easy to store and retrieve complex spatial information from Silla and Gaya cemeteries using GIS techniques. GIS is an especially efficient tool in sorting the hundreds of graves complicatedly overlaid into several layers or 'slices'. Each slice is expected to show meaningful spatial organization related to the social configuration of one period. If the time span of each period is controlled based on the reliable chronology, the GIS technique makes it possible to represent the formation process of cemeteries in detail.

For the analysis, all available spatial and non-spatial data from excavated graves of Silla and Gaya cemeteries were recorded in shapefile format, a proprietary GIS file format of ESRI. We have recorded the data from the cemeteries excavated in large scale or by whole-site method. Yimdang-dong and Siji Uksu-dong burials in Gyeongsan, the Hakcheon-ri site in Pohang, as well as Cheong-ni and Shinheung-ni in Sangju are significant samples where hundreds or thousands of graves were concentrated over a long-term period. Among these cemeteries, in the case of Hakcheon-ri, the whole-site was excavated, and over 900 of the Yimdang-dong burials were excavated during a sixteen-year period. We have also recorded the important Silla and Gaya cemeteries, for examples Bockcheon-dong in Busan, Joil-li in Ulsan, Cheongjeong-ri in Youngcheon, Seobyeon-dong in Daegu, and so on. We consider the type of burial structure, class diversity and amount of grave goods, size of internal structure, value of ranking, period, and the existence of specific important artefacts as the chief attributes that each grave has. Among these we estimate the value of ranking according to the size of burial structure and the level of grave goods. Additionally, individual graves of the sample cemeteries are assigned to the 6 periods that we have divided and defined in advance based on the pottery chronology of Kim, Y.-S.(金龍星: 1996) and Lee, S.-J.(李盛周: 1999).

We use 1:5000 scale Korean national digital maps published and distributed by Korean

Ministry of Transportation and Construction as base maps in creating shape file format data. All the graves of interest were recorded as polygons in shapefile format. ArcGIS 9.0 and ArcView 3.2 were used to visualize and analyze the data.

3. *Space, Time and Pre-Dispositions*

This paper describes research on the spatial organization of the graves in Silla and Gaya cemeteries from an intra-site perspective. For this research it is necessary to make assumptions about the nature of cemetery as an archaeological record, in three dimensions, because it is expected that the past social group did not use the given space randomly or without any consideration of spatial size and time span in one cemetery and the number of the future burials. Those three dimensions were in the cognition of ancient social groups and were dependent upon the choices of them. They selected the location for the burial of individuals and prepared the vacant space for the future burials based on the cognition of the space and span of time in usage expectation and the pre-existing dispositions of cemetery. Closely correlated to each other, those three dimensions became a basis of the choices of past social groups and ultimately played critical role to determine the spatial size, the density, and distributional patterning.

First, conceiving of the total spatial size and the topographical location is very important for the configuration of a cemetery. It could be assumed that the member of past social groups had, concretely or not, conceived of the topographic setting and the total space for their cemeteries. Under this consideration, they made a choice how to use the total space of cemetery, to expand it or not, and leave it or not. If the whole cemetery was filled up with burials, then some communities continuously used the vacant place available, the others moved to another place.

Second, it is apparent that the ancient community knew that over the long-term there would be space limits, and so they tried to calculate the number of the future burials and the space required for deposition of them. If the ancient social groups had borne the total area for their cemetery in mind, they should have estimated what amount and direction of the vacant space should be left for the future burials. And under this consideration, they expanded the space of the cemetery into neighbour area or filled the vacant place, otherwise, the pre-existing grave distribution was overlaid with successive placement of burials.

Third, the considerations of where the pre-existing burials are disposed, the identity of those interred in burials and what relationship they had with the newly buried are important to determine the growing pattern in the short run and the whole configuration of cemetery. The individual grave could have a specific outer appearance or not. Some graves of Silla and Gaya period have enormous tumulus of the monumental scale. In some low ranked
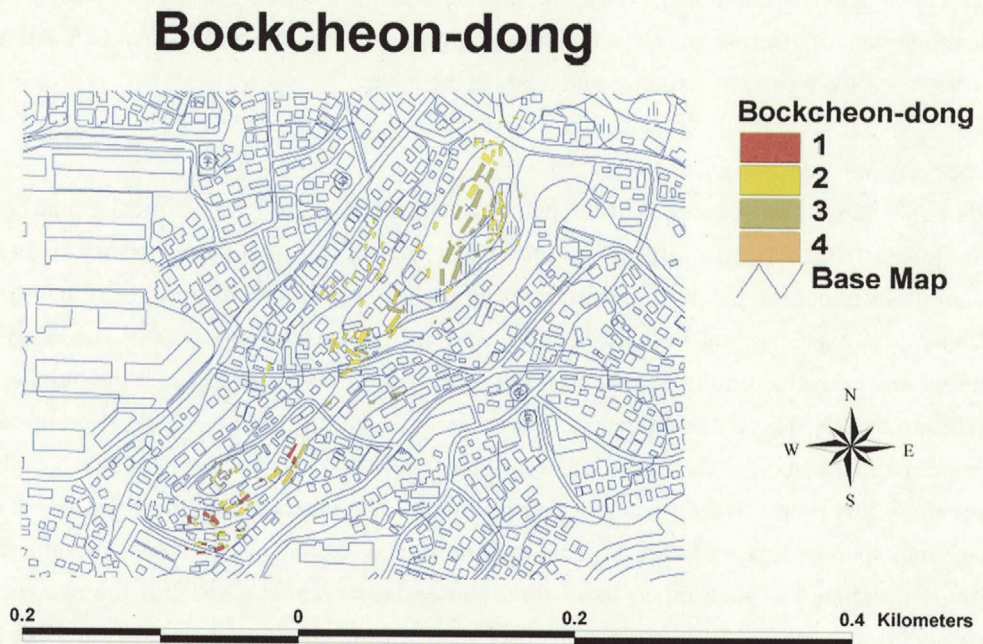
Bockcheon-dong

Bockcheon-dong
1
2
3
4
Base Map

0.2   0   0.2   0.4 Kilometers

Fig.2 The distributional pattern of Bockcheon-dong Burials from AD4th century to 5th century

burials, any marking of the grave existence could be hardly detected even through the excavations. Yet at a glance, the construction of additional burials never ignored or destroyed the pre-existing burials until the cemetery space was completely filled out. So it is highly probable that ancient community members recognize the distribution of pre-disposed graves. They tried to represent some meaningful relationship between the disposed members and the newly deceased in the deposition of additional member.

4. Representation of Cemetery Growth with GIS

The Silla and Gaya cemeteries had been formed in various processes. In any respect, it cannot be denied that the formation processes of cemeteries are reflections of transformation processes of the social groups. A few cases had started as small elite burials, grew up to the royal cemetery of one local polity and maintained its rank for 4 or 5 hundred years. Some cemeteries had begun as elite burials, but after several decades declined to the lower rank. Many cemeteries began to be formed from 4th century AD or 5th century AD. Especially from the mid-5th century AD a large number of newly formed cemeteries emerged. It is because the lower groups who did not have their own cemetery were able to construct burials in a certain area and use it exclusively

The first burials of the Bockcheon-dong cemetery were built in the 2nd century BC in

Fig.3 The distribution of burials during early 4th century

Fig.4 The cummulative distrubution of vurials late 4th century

Fig.5 The cummulative distribution of burials early 5th century

Fig.6 The cummulative distribution of burials late 5th century

the southwest part of the lower zone surrounding the Bockcheon hill. Now, the buildings of modern Busan spread onto the earliest burials. From the late 3rd century AD, it became the royal cemetery of the polity that occupied the Busan area. After the wooden chamber with

large internal structure was adopted for elite group burials in the late 2nd century AD, the ranking between graves was steadily increased. From third century AD, spatial organization became more important than any other dimensions of intra-cemetery differentiation of burials. In the highest ranked cemetery of a polity, like Bockcheon-dong, the hierarchical spatiality has a tendency to be represented in association with the topographical location. The elite burials of the highest rank were sequentially disposed along the ridge of the elongated hill, surrounded by the lower rank graves of hill slope, and the lowest were distributed at fringe of the hill. As such, the contour of the ranking in the grave distribution roughly corresponds to that of the topography. From late 3rd century to mid-5th century, for about 2 hundred years, Bockcheon-dong showed the formation process of elite group cemetery typically. The one period clusters of the graves, which had been formed according to the rigorous order, sequentially occupied the Bockcheon hill, moving forward to the higher place. Yet in the Bockcheon-dong cemetery, the spatial organization was seriously transformed at late 5th century. The highest rank graves were placed not on the centre of hilltop, but near the hill slope. We cannot give an adequate explanation as to why this might be. However the social group of the Bockcheon-dong burials had practiced their mortuary ritual under the very persistent conceptualization about the boundary and topographic setting of the royal cemetery (Lee 2004).

We detected a similar growth pattern in the Hakcheon-ri burials, especially among the lower rank cemeteries of local groups. The periodic slices from the GIS shapefile clearly show the linear movement of the burial groups until 5th century AD and sudden change of distributional pattern. The cemeteries that had begun before the 4th century AD expanded their space in a specific direction. The Yimdang-dong site has 5 small flat hills. The hill located in central part was occupied by elite residence. On the other 3 hills royal tombs assigned to the 5th and the early 6th century were distributed. The cemeteries of each period had their own area, but from the 5th century AD, the lower rank burials were distributed a considerable distance from royal graves (Jang 2002). Although not included in this paper, it is very interesting for us to analyze the distribution of the burials with specific attributes from the GIS data files. We have especially tried to detect the grouping and inter-relationship of the graves that have some characters in common, inferred from the specific associations of the grave artefacts.

CEMETERY GROWTH DURING 5TH CENTURY AD.

The hierarchical tendency between graves within a cemetery and cemeteries within a polity was steadily increased from 3rd century to 5th century. In the higher rank cemeteries, the process is more clearly represented in the cumulative spatial organization for 200 years than

Fig.7 Siji Uksu-dong cemetery. From 5th century to 6th century, 200 years of the accumulation of graves

the comparison of grave scale or the amount and quality in grave goods. The trend of hierarchical differentiation in burials and cemeteries might be reflections of the ranking process between individuals within the elite groups and the regional groups within a polity. During the 5th century, dramatic change in the spatial organization of the higher rank cemetery took place. In some cemeteries, this change occurred relatively earlier than others.

In the lower rank cemeteries also, the 5th century was very significant period with regard to the temporal variations of the spatial organization. The cemeteries that had started before the 4th century showed relatively simple growth pattern until the early 5th century. In this period, the cemeteries simply expanded their space for the new burials. In short, it showed a typical linear growth pattern. Soon after the early 5th century, the whole space of the cemetery began to be utilized. So the cemetery development did not follow the linear growth pattern. From this period, the growing patterns of some cemeteries, especially in Silla territory, could be regarded as the increase of the grave density rather than the spatial expansion. This density increase pattern could be observed in many excavated cemeteries formed during the 5th and 6th century, such as Siji Uksu-dong, Joil-li, Hakcheon-ri, Cheongjeong-ri, Gacheon-dong burials, and so on. The most typical pattern seems to be discovered at the sparsely accumulated cemeteries. Hardly can it be assumed, however, that the growing pattern could be a result of the random deposition of the dead.

In this paper we suggest hypothetical models of cemetery growth (Mizoguchi 2002:

<Table1> Mean nearest Neighbour Distance: Individual Period

	Period II	Period III	Period IV	Period V	Period VI
Mean Nearest Neighbour Distance	3.98	5.87	4.37	4.55	7.2

<Table2> Mean nearest Neighbour Distance: Cumulative Period

	Period II	Period II & III	Period II, II, & IV	Period II, III, IV & V	Period II, III, IV, V, & VI
Mean Nearest Neighbour Distance	3.98	3.76	3.04	2.97	3.03

<Table3> Distributions of Graves: Hakcheon-ri

	PeriodII	PeriodIII	PeriodIV	PeriodV	PeriodVI
Total*	79	34	93	140	47*
Ratio of correspondent distribution *		13(38.24%)	73(78.49%)	37(26.43%)	27(57.45%)

*: Number of graves in the period.

**: Number of graves in T period within the grave area of period T-1

140-147; Parker-Pearson 1999:11-15). We define three types on the basis of the ways utilizing the cemetery space within the conceptualized boundary. The first growth type is grave density increase by the random deposition of the new burials, but it is not expected to have existed in Silla and Gaya cemeteries. The second type is the development with the gradual expansion of the cemetery space to the boundary conceptualized by the ancient social group. The third growth is also a kind of density increase type. Before constructing new burials, the whole cemetery space is subdivided into the many sectors. And the burial of individuals is pre-determined in the prepared sector. It cannot be well interpreted, without considering the existence of the many social subunits that exclusively occupied the mortuary space.

In 5th century, the noticeable transformation of the spatial patterning caused by the replacement of the linear growth principle with the sectored growth took place in the Silla and Gaya cemeteries. We would like to confirm whether the transformation did really occur, and if so would like to know when the process did start. For this study we introduced the two concepts of Grave Area and Cumulative Grave Area, which we summarize below.

Fig.8 Distribution of 5th century graves and the cumulative distribution from mid-5th century to early 6th century.

1) Grave Area:

Grave area of T period is the vicinity of all the graves established in T period. In this study, the _vicinity_ is defined by mean nearest neighbour distance from the nearest neighbour analysis applied to the graves of T period. The mean nearest neighbour distance is the average of the distances from each grave to the nearest neighbour grave. The mean nearest distance was used to generate the buffer around the graves of T period by using GIS. The resulting buffer area is the grave area of T period.

2) Cumulative Grave Area:

Cumulative grave area of T period is the vicinity of all the graves established until T period. The only difference between grave area and cumulative grave area is that the latter considers all the graves established both in T period and before T period while the former only considers graves established in T period.

It is possible to hypothesize that if the deposition of the deceased is practiced in the way of the sectored principle during the given periods (T and after T (T+1) periods), the grave area of T+1 period would be roughly correspondent with that of T-period. And if we
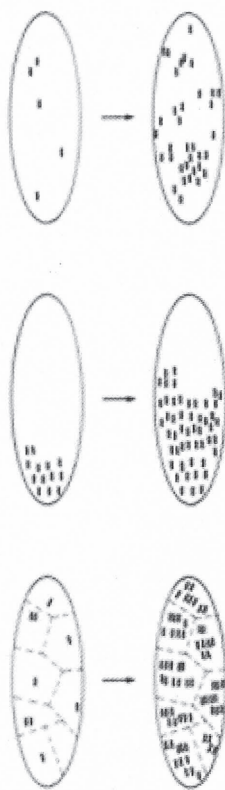
define the shorter initial stage in the sectored growth period, we could know when the sectored deposition began. For the analysis, we select the Hakcheon-ri sample. Because it is thought to represent well the transformation process during the 4th and 5th centuries. As the results of the analysis, we would like to present the <Table 4> and Figure 15 to explain the change in the spatial organization. Noticing the <Table 3>, the ratio of the later period graves disposed within the buffer zones of former period is higher in the Period ¢° (late 5th century) and Period ¢ª (early 5th century). We admit that it should be a result of the mortuary practice in the Period _ during which individuals of the late 5th century were disposed within each sector prepared in former period (early 5th century). In Period _ (early 6th century), the correspondent ratio becomes low. It is because the limited spaces of the 5th century sectors were filled out with burials for 60 or 70 years. So the burials of Period _ (early 6th century) were deposited in new sectors in other places within the same cemetery. From the observation of the whole spatial process in Hakcheon-ri cemetery, we could suggest that burials were built based on the linear expansion type should have continued before the mortuary practices following the sectored principle.

Fig.9 Types of cemetery growth

CONCLUSION

From this research we conclude that GIS techniques are a very powerful tool to investigate the spatial organization of ancient cemeteries. Especially in case of the cemeteries where a large number of graves are concentrated over a deposition history of hundreds of years, GIS can aid in discriminating the temporal and other variations of the spatial organizations. We represented the temporal variations of spatial patterning in the Silla and Gaya cemeteries with the periodic slices from the GIS shape file.

We explicated the major changes in spatial patterning that took place during the 5th century. Archaeologists and historians have argued that Silla society of the 5th century would have been very dynamic, since it emerged as a centralized state during that time. This change was not limited to the central government because local societies also experienced a major transformation in their internal organization. During the 5th century, the social organization of local group disintegrated and subsequently reintegrated. Some historians interpret the devolution as the emergence of sub-units in local communities based on kinship principles (Kim 1991). Following this suggestion, archaeologists have argued that the conceptual
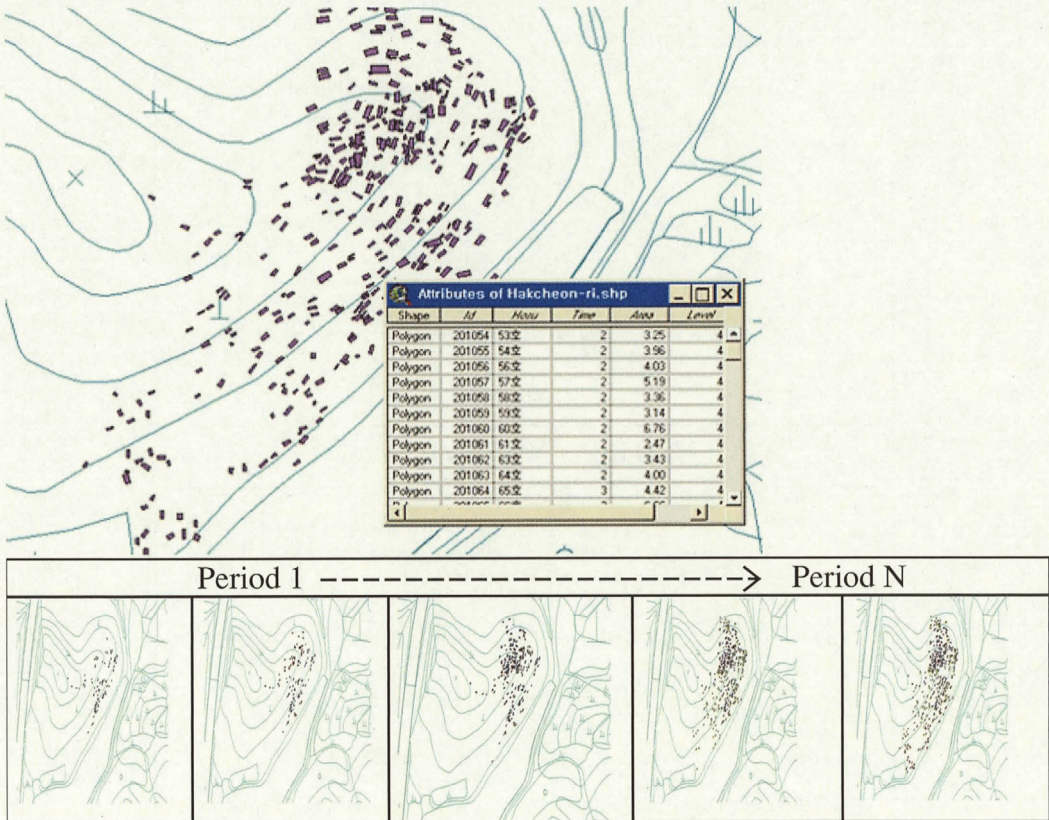
Fig.10 Interactive Mapping & Visialization by Area and Time Period

meaning of mortuary practices changed from emphasizing the ritual of communities to that of families, and that from the 5th century, family burial groups were constructed (Lee 1998). The change in the social meaning of the mortuary behaviour is roughly correspondent with the transformation in the cemetery growth pattern. However we cannot firmly accept that the prepared sectors of the early 5th century were the very family areas in the mortuary practice.

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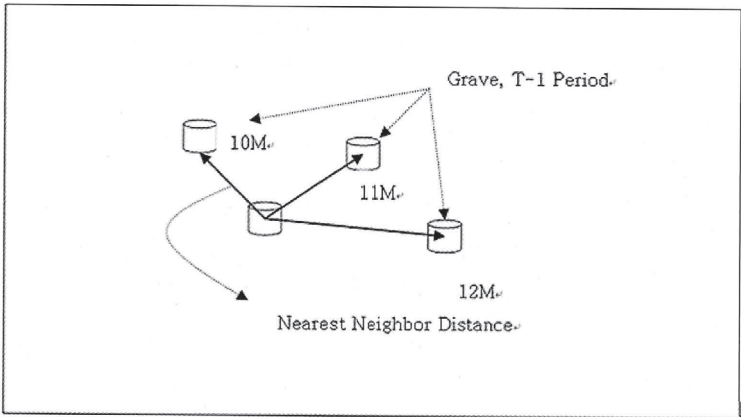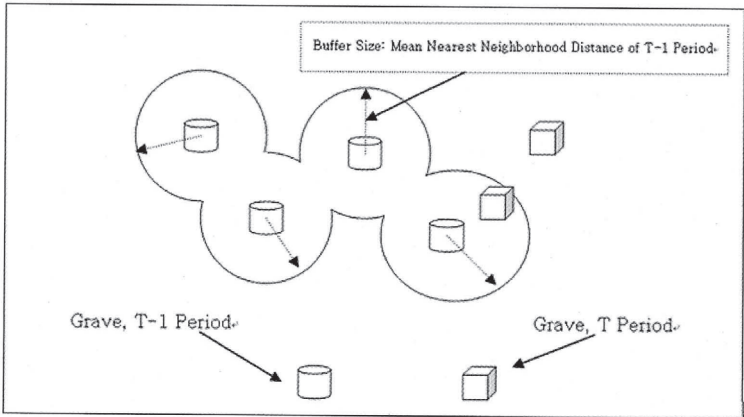
Fig.11 Nearest Neighbour Distance

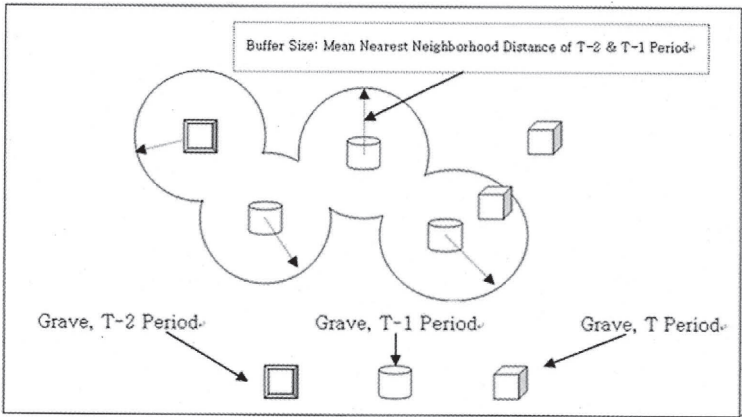**Fig.12** Grave Area of T-1 period based on Buffering

Fig.13 Cummulative Grage Area of T-2&T-1 Periods based on Buffering

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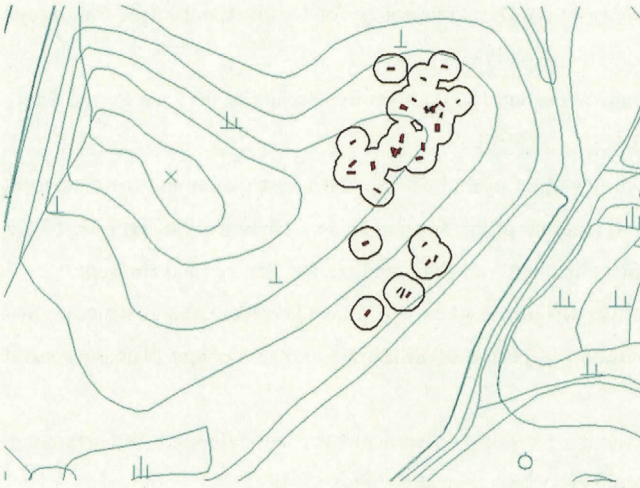
Fig.14 Buffer Area, PeriodII: Hakcheon-ri

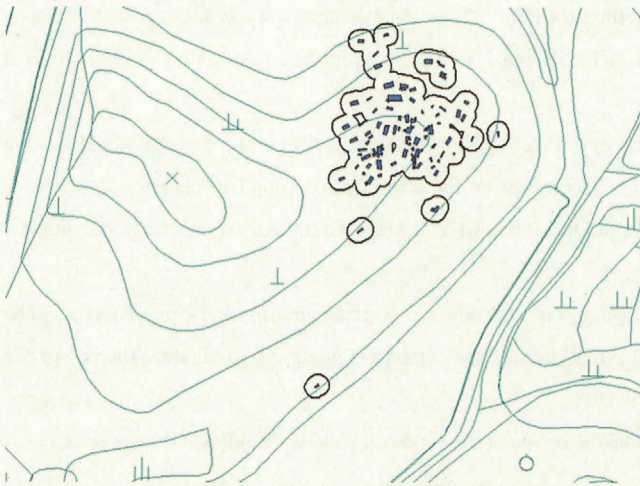**Fig.15** Buffer Area, Period III: Hakcheon-ri

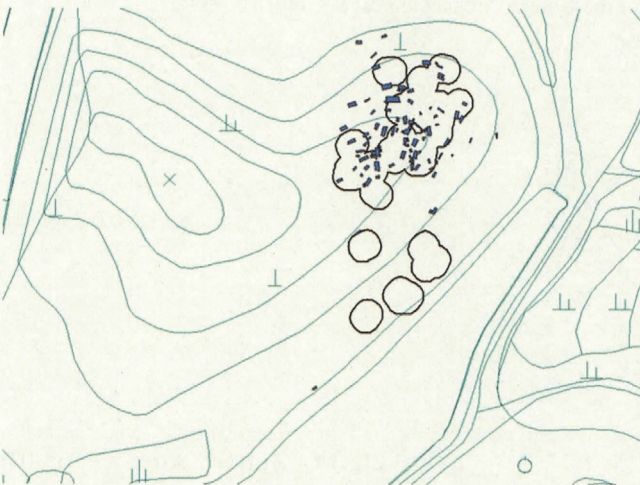**Fig.16** Buffer Area, Period IV: Hakcheon-ri

Fig.17 Graves of Period IV within the Buffer Area of Period III:Hakcheon-ri

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