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SERVICES FOR SCIENCE AND EDUCATION

Traces of Ancient Surveying in Japan

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ABSTRACT

Grasping the geography/topography of the land is one of the most important tasks in nation-building throughout the ages. In Ancient Izumo Province, Mt. Daisen and Mt. Sanbe were clear landmarks for the purpose. On the other hand, a large number of bronze artifacts were excavated from Shidanioku Site, Kojindani Site, and Kamo-iwakura Site in this province. These bronze artifacts were buried around the 1st century AD. If we examine the correlation using the latitude and longitude (numerical data) of landmark mountains and the bronze burial sites, we will find that Mt. Daisen, Mt. Sanbe, and the Shidanioku Site form a large isosceles triangle. It can also be seen that Mt. Daikoku and Mt. Takase, as well as Kojindani Site and Kamo-iwakura Site, which are seen as two pairs, form two isosceles triangles with a common base. They show that Ancient Izumo Province in the 1st century AD had maps for selecting burial sites and surveying techniques for making maps. There was also surveying techniques for indicating the burial sites in the field. These are the oldest surveying traces in Japan for which evidence can be shown.

Keywords: ancient surveying, ancient maps, bronze artifacts, Kojindani Site, Ancient Izumo Province.

INTRODUCTION

Rice cultivation was introduced to Japan from the downstream area of the Changjiang River in China during the Yayoi period (In general, 3rd century BC to 3rd century AD). At that time, it is believed that there was surveying technology for creating paddy fields and constructing irrigation systems. However, descriptions about surveying methods and related relics have not been remained. It is also unknown whether or not a surveying was conducted to grasp the geography/topography of wide area. Izumo region (provisionally named Ancient Izumo Province) in the eastern part of Shimane Prefecture, which is the subject of this study, is an area of about 80 km from east to west and about 60 km from north to south.

Many relics from the Yayoi period have been confirmed in this area. Especially, as Table 1 shows, the number of bronze artifacts excavated in Izumo region is greater than that in other regions of Japan. From 1984 to the following year, 358 bronze swords, 16 bronze socketed spearheads, and 6 bronze bells were excavated from Kojindani Site. Subsequently, 39 bronze bells were excavated from Kamo-iwakura Site in 1996. These discoveries reminded us that 3 bronze bells and 6 bronze swords were excavated at Shidanioku Site in 1972. These bronze artifacts were used for rituals and are said to have been buried in the 1st century AD in Izumo region [1]. However, the detailed usage pattern and the reasons for burial are unknown.



(a) Kojindani Site. **(b) Kamo-iwakura Site.**

Figure 1: Restored bronze artifacts.

Table 1: Sites (Remains) where many bronze artifacts were excavated in Japan.

Name of Site	Prefectrure	bronze sword	bronze socketed spearhead	bronze bell	bronze dagger-axe
Yanagisawa	Nagano			6	8
Oiwayama	Shiga			24	
Sakuragaoka	Hyogo			14	7
Kojindani	Shimane	358	16	6	
Kamo-iwakura				39	
Shidanioku		6		3	
Hoshigochi	Tokushima			7	
Gahaishisan	Kagawa	5		1	
Haramachi	Fukuoka				49
Momijigaoka					27
Antoku-harada			12		



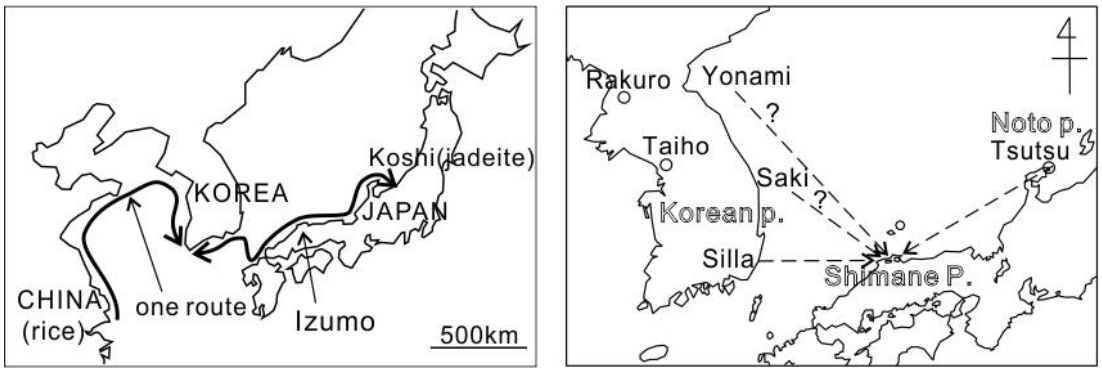
(a) Replicas of the bronze artifacts. (b) Bronze dagger-axe and "Magatama" of jadeite.

Figure 2: Bronze artifacts [1].

Another characteristic of Ancient Izumo Province is one of the most mythological areas in Japan. The "Kunibiki (pulling land) Myth" recorded in the Izumo-no-kuni Fudoki (edited in 733, abbreviation: Izumo Fudoki) is a magnificent myth related to geography/topography. The Shimane Peninsula, which faces the Sea of Japan, was created by a god pulling together four lands, including the Korean Peninsula and the Noto Peninsula. Then, Mt. Daisen and Mt. Sanbe were used as piles to tie the lands. This myth tells us that Mt. Daisen and Mt. Sanbe played an important role in the creation of the province at the beginning.

Mt. Daisen and Mt. Sanbe, landmarks that represent this region, are now designated as a same national park, although they are far apart.

This paper describes the existence of surveying techniques and maps in the early days of Japan by grasping the relationship between the landmark-mountains and the sites of bronze artifact burials in Ancient Izumo Province.



(a) Location of Izumo Province. **(b) Mythology of "Kunibiki".**

Figure 3: Location of Izumo Province and Mythology of "Kunibiki".



Figure 4: Landscapes of mountains.

EXISTING LITERATURES

Organize literatures on ancient surveying and geography/topography in Japan.

Civil Engineering Field

Pre-Meiji Civil Engineering History describes that a part of the body was used as a scale in ancient times [2]. Though, there is no mention of surveying about a wide area in the time.

Michiharu TAKEDA summarized the development process of surveying technology from ancient times to the present in 1979.

The oldest map in the world is drawn on papyrus around 1330 BC in Ancient Egypt. Around 600 BC, Thales of Ancient Greek applied today's Forward Intersection Method. The oldest map in China is the one for Changsha around 150 BC. The oldest national map in Japan is Gyoki-zu compiled in 743（the original not existing）. The triangulation method was developed in 1617 by Snellius of Holland.

Surveying technology has existed since ancient times, but there are no maps to prove it. Instead of them, the existence of surveying techniques can be inferred from the geometric shapes and orientations of ancient structures such as pyramids, as well as from the relative positions of the structures [3].

Toshiaki KIMURA, in a series of articles from 1982 to 1989, argued that the layout of ancient facilities and the plan designs of keyhole-shaped burial mounds were influenced by Egyptian geometry (Pythagorean theorem, golden section, etc.) [4].

The gold seal (bestowed by the King of Han in China in AD 57) excavation site of Island Shika, shrines, an isle and hills form two isosceles triangles [5].

Takanobu SUMATA developed his theory from 1990 to 1997. The keyhole-shaped burial mounds were built using geometry and advanced construction techniques, and corresponding surveying techniques must have existed. Lines connecting famous ancient sites and burial mounds often refer to directions of east-west, north-south, 30° and 60° [6].

Kenichi TAKEBE commented in 2000 on the articles of KIMURA and SUMATA in his paper on the history of civil engineering. There is a tendency not to regard the elucidation of the geometric figures of ancient site as orthodox research. One reason is that the interpretation of the geometry of ancient burial mounds can be considered arbitrary. However, since they have extremely theoretical aspects, it should be thoroughly discussed in the Japan Society of Civil Engineers [7].

Other Fields

Toshio KISHI, a scholar specializing in ancient Japanese history, wrote in 1970 that the four major burial mounds (Yanagimoto, Umami, Furuichi, Mozu) are almost on the same line from east to west, and the old road runs near this line. Hashihaka-Kofun is located due east of Mt. Futakami, a local landmark [8].

Photographer Kozo OGAWA noticed in 1973 that ancient mounds, old shrines, mountain summits, and passes are located along the east-west line from Ise in the east to Awaji in the west [9].

Keiichi MIZUTANI, a TV director, verified OGAWA's theory to produce a TV program and wrote a book about the background in 1980 [10].

STUDY POLICY

Relationship Between Past Articles and This Paper

In the previous section, we dealt with ancient surveying and geography/topography, but they are from the 3rd to 5th centuries. As an exception, the gold seal was given and received in the 1st century, but when it was buried is unknown.

From the above articles, we have obtained the following knowledge.

- Surveying and geometric figures are thought to have been widely used from the 3rd to the 5th century. However, in Japan, there are no descriptions of surveying from earlier eras.
- As TAKEBE comments, these analyzes have not been evaluated in the civil engineering field. This is thought to be due to the fact that the interpretation of figures is considered arbitrary, and the verification is difficult.

Study Policy of this Paper

Based on the problems of past articles, we consider in the following policy.

- Problem 1: There is arbitrariness in the interpretation of geometric figures.

In order to ensure objectivity and facilitate verification, numerical data such as latitude and longitude are used to grasp the positions. In that case, we use published data as much as possible.

- Problem 2: The subject of examination is wide-ranging.

We reduce the number of subjects to study and only deal with numerical location data.

- Problem 3: Evaluation cannot be made without expert knowledge of Chinese or Egyptian geometry. Directly, if the reviewers of the paper do not have knowledge, it will not be evaluated.

We deal with only phenomena and explain simply.

Therefore, we don't interpret the purpose and circumstances for burying the bronze artifacts. However, this paper will be a valuable resource for such studies.

LOCATIONS AND COORDINATES OF THE STUDY POINTS

Figure 5 shows the landmark mountains and the locations of the bronze artifact burials.

Figure 6 shows Mt. Daisen as seen from Mt. Sanbe.



Figure 5: Map of Izumo Province.



Figure 6: View from Mt. Sanbe to Mt. Daisen.

Table 2 summarizes the latitudes and longitudes (coordinate values of the geodetic system) of the landmark-mountains of Ancient Izumo Province and the bronze burial sites. The most conspicuous landmarks in this province are Mt. Daisen (1729m) and Mt. Sanbe (1126m), both independent peaks which can see each other. To grasp the geography of Ancient Izumo Province, we consider Mt. Daisen - Mt. Sanbe is the most important surveying baseline. Next, we should focus on 4 sacred mountains (Kamnabi-yama) and 5 beacon-mountains that stand out from afar and serve as landmarks. Nine mountains above mentioned are based on Izumo Fudoki. Two mountains (Mt. Daikoku and Mt. Takase) were also selected during the

consideration process for the nation-building myth and as landmarks. The bronze artifact burial sites are Shidanioku Site (Remains), Kojindani Site (Remains), and the Kamo-iwakura Site (Remains). According to Table 2, Mt. Daikoku is located due west (error 4") relative to the latitude of Mt. Daisen. Mt. Takase (error 30"), Mt. Bukkyo (error 47"), Kojindani Site (error 19.3"), Kamo-iwakura (error 40.5"), depending on the situations, it may be said that these are also due west of Mt. Daisen.

Table 2: Latitudes and longitudes of Mountains and Sites (Remains).

	Attitude (m)	Latitude			Longitude			Source
		deg	min	sec	deg	min	sec	
Mountains								
Daisen	1729	35	22	16	133	32	46	a)
Sanbe	1126	35	8	26	132	37	18	a)
Dake	331	35	29	12	133	6	28	b)
Asahi east-peak	342	35	30	34	132	58	51	b)
Bukkyo	366	35	21	29	132	49	49	b)
Ohbukuro	360	35	18	9	132	46	49	b)
Daikoku	315	35	22	20	132	52	16	b)
Takase	314	35	21	46	132	51	49	b)
Sites (Remains)								
Shidanioku	–	35	31	2.0	132	59	28.8	c)
Kojindani	–	35	22	35.3	132	51	8.9	c)
Kamo-iwakura	–	35	21	35.5	132	53	0.3	c)

Notes: a) List of mountains by the Geospatial Information Authority of Japan [11] . b) Measurement on the map. c) Archaeological Database of Shimane [12].

POSITIONAL RELATIONSHIP BETWEEN SHIDANIOKU SITE, MT. DAISEN AND MT. SANBE

Table 3: Positional relationship of two points.

Positional relationship		Distance (km)	Azimuth
1)	Mt. Daisen - Mt. Sanbe	87.93	253.355194
2)	Mt. Daisen - Mt. Dake	41.82	287.980197
3)	Mt. Daisen - Mt. Daikoku	61.34	270.310519
4)	Mt. Daisen - Shidanioku S.	52.91	288.009111
5)	Mt. Sanbe - Mt. Daisen	87.93	72.821569
6)	Mt. Sanbe - Mt. Asahi east-peak	52.36	38.484283
7)	Mt. Sanbe - Mt. Bukkyo	30.70	38.135303
8)	Mt. Sanbe - Mt. Ohbukuro	23.05	38.743544
9)	Mt. Sanbe - Shidanioku S.	53.63	38.702153
10)	Mt. Sanbe - Kojindani S.	33.56	38.658914
11)	Shidanioku S. - Mt. Daisen	52.91	107.679189
12)	Shidanioku S. - Mt. Sanbe	53.63	218.915919
13)	Mt. Daikoku - Mt. Takase	1.25	213.044978
14)	Mt. Daikoku - Kojindani S.	1.76	285.562400
15)	Mt. Daikoku - Kamo-iwakura S.	1.77	140.801114
16)	Mt. Takase - Mt. Daikoku	1.25	33.040636

17)	Mt. Takase - Kojindani S.	1.83	326.330214
18)	Mt. Takase - Kamo-iwakura S.	1.83	100.185625
19)	Kojindani S. - Mt. Daikoku	1.76	105.551611
20)	Kojindani S. - Mt. Takase	1.83	146.323767
21)	Kojindani S. - Kamo-iwakura S.	3.36	123.230094
22)	Kamo-iwakura S. - Mt. Daikoku	1.77	320.808236
23)	Kamo-iwakura S. - Mt. Takase	1.83	280.197086
24)	Kamo-iwakura S. - Kojindani S.	3.36	303.248006

Note: Each azimuth angle was obtained from the calculation site of the Geospatial Information Authority of Japan.

Table 4: Positional relationship of three points.

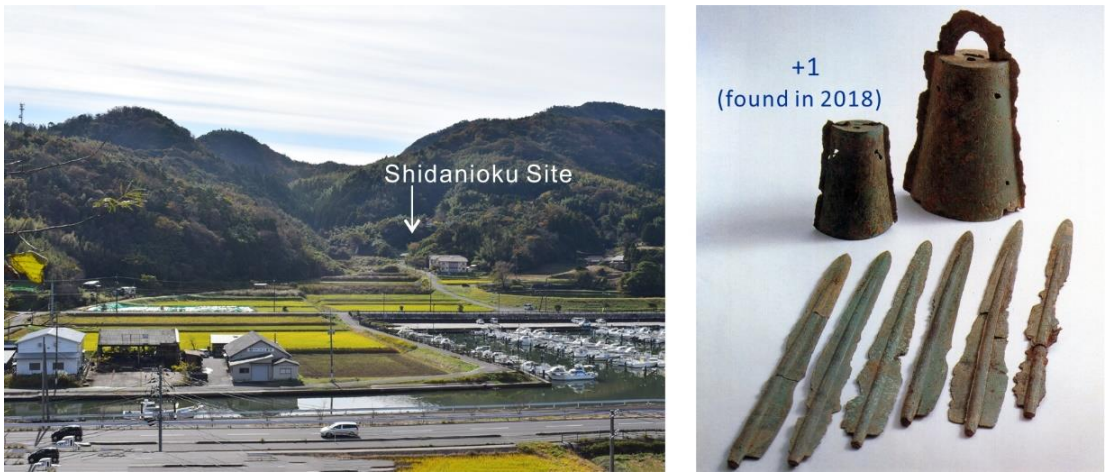
Positional relationship	Calculation	Angle	Remarks
Shidanioku S. - Mt. Daisen - Mt. Sanbe	4) - 1)	34.65	same angle
Shidanioku S. - Mt. Sanbe - Mt. Daisen	5) - 9)	34.12	
Mt. Daisen - Shidanioku S. - Mt. Sanbe	12) - 11)	111.24	total of above, 180.01°
Mt. Daiaen - Mt. Dake - Shidanioku S.	4) - 2)	0.03	straight line
Mt. Sanbe - Mt. Asahi.ep. - Shidanioku S.	9) - 6)	0.22	straight line
Mt. Sanbe - Mt. Bukkyo - Shidanioku S.	9) - 7)	0.57	straight line
Mt. Sanbe - Mt. Ohbukuro - Shidanioku S.	8) - 9)	0.04	straight line
Mt. Sanbe - Kojindani S. - Shidanioku S.	9) - 10)	0.04	straight line
Kojindani S. - Kamo-iwakura S. + Mt. Daikoku - Mt. Takase	13) - 21)	89.81	right angle
Mt. Daikoku - Kojindani S. - Kamo-iwakura S.	21) - 19)	17.68	same angle
Mt. Daikoku - Kamo-iwakura S. - Kojindani S.	22) - 24)	17.56	
Kojindani S. - Mt. Daikoku - Kamo-iwakura S.	14) - 15)	144.76	total of above, 180.00°
Mt. Takase - Kojindani S. - Kamo-iwakura S.	20) - 21)	23.09	same angle
Mt. Takase - Kamo-iwakura S.- Kojindani S.	24) - 23)	23.05	
Kojindani S. - Mt. Takase - Kamo-iwakura S.	360° - 17) + 18)	133.86	total of above, 180.00°

Table 3 shows the azimuths of the two points obtained from the coordinate calculation site of the Geospatial Information Authority of Japan.

Table 4 summarizes the positional relationships (triangles, etc.) between the three points. From this table, the angle Shidanioku Site - Mt. Daisen - Mt. Sanbe is 34.65°, the angle Shidanioku Site - Mt. Sanbe - Mt. Daisen is 34.12°, and the angle Mt. Daisen - Shidanioku Site - Mt. Sanbe is 111.24°. Two angles are almost same, ΔMt. Daisen - Shidanioku Site - Mt. Sanbe can be said to form a large isosceles triangle. The sum of the triangle angles is 180.01°, and the effect of the Earth being spherical can be ignored.

According to Table 4, it can be also confirmed that Mt. Dake is located on the line from Mt. Daisen to Shidanioku Site. On the other hand, Mt. Asahi east-peak, Mt. Bukkyo, Mt. Ohbukuro, Kojindani Site are located on the line from Mt. Sanbe to Shidanioku Site. We can understand that Sidanioku Site is a geographical singularity.

Because of this reason, it is thought that the location of the Kojindani Site was decided after Shidanioku Site.



(a) Sidanioku Site. (b) Excavated bronze bells and bronze swords [1].
Figure 7: Shidanioku Site and Bronze artifacts.

POSITIONAL RELATIONSHIP OF THE REMAINS SITES AND THE MOUNTAINS IN THE WESTERN REGION

According to Table 4 and Figure 8, the angle between the two lines of Kamo-iwakura Site - Kojindani Site and Mt. Daikoku - Mt. Takase is 89.81°, the relation can be said orthogonal.

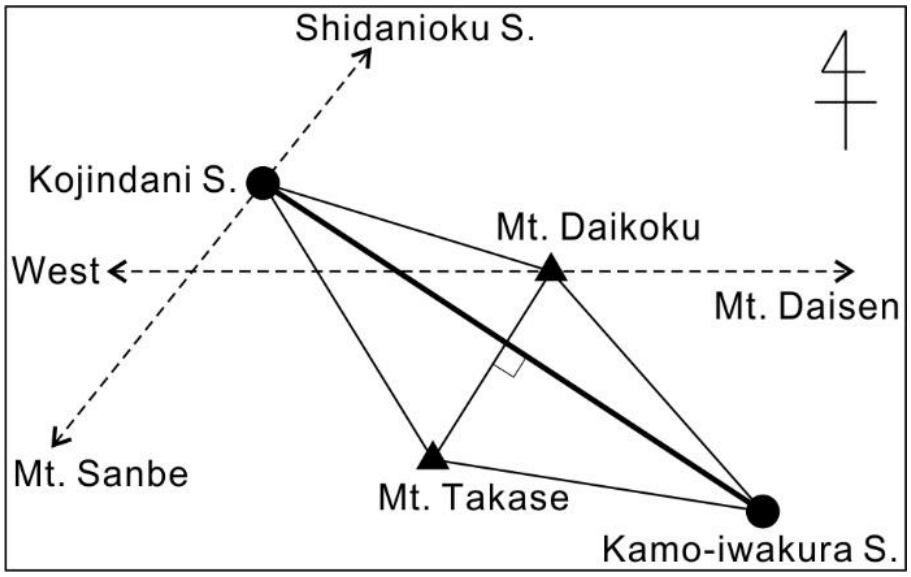


Figure 8: Positional relationship of two mountains and two sites.

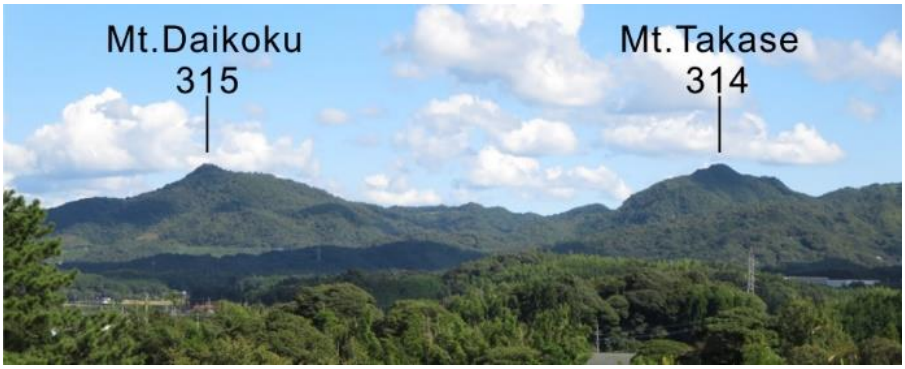


Figure 9: Mt. Daikoku and Mt. Takase.

Similarly, looking at Table 4 and Figure 8, the angle Mt. Daikoku - Kojindani Site - Kamo-iwakura Site is 17.68°, the angle Mt. Daikoku - Kamo-iwakura Site - Kojindani Site is 17.56°, the angle Kojindani Site - Mt. Daikoku- Kamo-iwakura Site is 144.76°, and the total is 180.00°. Therefore, ΔMt. Daikoku - Kojindani Site - Kamo-iwakura Site is an isosceles triangle.

The angle Mt. Takase - Kojindani Site - Kamo-iwakura Site is 23.09°, the angle Mt. Takase - Kamo-iwakura Site - Kojindani Site is 23.05°, the angle Kojindani Site - Mt. Takase - Kamo-iwakura Site is 133.86°, and the total is 180.00°. ΔKojindani Site -Mt. Takase - Kamo-iwakura Site is also an isosceles triangle. Therefore, we can say that there are two isosceles triangles with the line of Kojindani Site - Kamo-iwakura Site as a common base.

PROSPECTS OF THE EACH SITE

Shidanioku Site

Shidanioku Site are obstructed by mountains and cannot be seen not only from Mt. Daisen and Mt. Sanbe, but also from relatively nearby Mt. Asahi and Mt. Dake. Therefore, it is impossible to determine the position only by the prospects from these summits.

Kojindani Site and Kamo-iwakura Site

Kojindani Site and Kamo-iwakura Site have no visibility to each other by mountains. In addition, Kojindani Site and Kamo-iwakura Site cannot be seen from the nearby Mt. Daikoku and Mt. Takase by mountains and trees.

PROCEDURES FOR BURIAL SITE SELECTION, SURVEYING TECH-NIQUES, AND EXISTENCE OF MAPS

Specialness of Burial Sites

Mt. Daisen and Mt. Sanbe are distinct landmarks and two peerless symbols in this region. In the "Kunibiki" mythology, Mt. Daisen and Mt. Sanbe are dealt with as a pair. As mentioned in the previous chapter, an isosceles triangle is formed by connecting Mt. Daisen, Shidanioku Site, and Mt. Sanbe. In addition, Mt. Dake is located on the line from Mt. Daisen to Shidanioku Site and Mt. Ohbukuro, Mt. Bukkyo, Kojindani Site, and Mt. Asahi east-peak are located on the line from Mt. Sanbe to Shidanioku Site.

However, since there is no direct line of prospect to each other except the line of Mt. Daisen - Mt. Sanbe, it is impossible to select points by field work alone. This shows that there was a clear intention for selection of the sites, and that existed some map.

Selecting the locations of the sites of Kojindani and Kamo-iwakura were as follows. Mt. Daikoku which is located due west of Mt. Daisen, and the line of Mt. Sanbe - Shiokudani Site were taken into consideration. The positional relationship was shown in Table 2. Then, Mt. Daikoku and Mt. Takase were selected, and two sites of Kojindani and Kamo-iwakura were decided. We can recognize same intention etc. above mentioned in the selection of two mountains and two sites. We consider that the mountain was selected so as to be "paired" with another one, and the burial site with another site. However, the connection between the "pair relationship" and Onmyodo (Ying-yang philosophy) is not clear.

Circumstances Surrounding the Excavation of Bronze Artifacts

The circumstances behind the excavation of bronze artifacts at the three sites are as follows.

- Bronze artifacts in Shidanioku Site were discovered when the slope of the path was excavated for agricultural work.
- Bronze artifacts from Kojindani Site were discovered from a hillside during preliminary survey for the construction of a farm road.
- Bronze artifacts from Kamo-iwakura Site were discovered from a hillside during construction of a farm road.

Similar works and constructions have already been carried out across Izumo region, but none have been found anywhere else. It is impossible to deny the specialness of the locations of these burial sites.

Procedure for the Burial Works

Shidanioku Site:

Based on the above assumptions, the procedure for selecting sites can be inferred as follows.

- In the geography/topography of Ancient Izumo Province, the most conspicuous mountains are Mt. Daisen and Mt. Sanbe. Therefore, the line connecting them was taken as the baseline.
- Select a singular point closely related to this line and make it a burial point. At the first step, the orthogonal line of the baseline was chosen.
- Coincidentally, the line connecting Mt. Daisen and Mt. Dake and the line connecting Mt. Sanbe and Mt. Ohbukuro, Mt. Bukkyo and Mt. Asahi intersect on the orthogonal line of the baseline. This is Shidanioku Site. It was decided to bury some bronze artifacts here.
- The peculiarity of Shidanioku Site cannot be known without a map. We can say that some map was existed.
- In this way, 3 bronze bells and 6 bronze swords were buried.

Kojindani Site and Kamo-iwakura Site:

Though a large number of bronze artifacts were buried at Kojindani Site and Kamo-iwakura Site, the reasons are unknown. The total weight of the bronze artifacts is several hundred

kilograms, so it may be due to transportation reasons. In any case, the overwhelming majority of bronze artifacts was buried in the western region of Ancient Izumo Province.

- In this region, the significant places are the line connecting Mt. Sanbe - Shidanioku Site and the line due west of Mt. Daisen.
- Due west of Mt. Daisen lies Mt. Daikoku. In addition, there is Mt. Takase to make a pair with this mountain.
- The point was selected where the orthogonal line of Mt. Daikoku - Mt. Takase intersects the line of Mt. Sanbe - Shidanioku Site. That is Kojindani Site.
- Kamo-iwakura Site was selected so that it was paired with the Kojindani Site.

Unknown Site:
There is a possibility that a counterpoint of the Shidanioku Site exists in the southern mountains.

Existence of Maps and Existence of Surveying Technology
The reasons and backgrounds of the burial of the bronze artifacts are unknown, but the following things can be said from the burial procedure.

- Judging from the positional relationship of the three burial sites, it is thought that the bronze artifacts were buried at the same time with the same intent.
- Since it is impossible to know the peculiarity of the burial sites only by field observation, it is thought that there was some map.
- At the time, there were surveying techniques for making the maps, and for selecting the burial sites in the field.

They were circumstances at the 1st century when bronze artifacts were buried at the three sites.

Surveying methods and map creation methods are future research topics that take into account the relationship with excavated artifacts.

CONCLUSION

If you connect Mt. Daisen and Mt. Sanbe, which are clear landmarks of Ancient Izumo province, and Shidanioku Site, where bronze artifacts were unearthed, it forms an isosceles triangle. The angles are 34.65° for Shidanioku Site - Mt. Daisen - Mt. Sanbe, and 34.12° for Shidanioku Site - Mt. Sanbe - Mt. Daisen.

In addition, Kojindani Site and the Kamo-iwakura Site, where many bronze artifacts were unearthed, form two isosceles triangles with the nearby landmarks Mt. Daikoku and Mt. Takase. The angles are 17.68° for Mt. Daikoku - Kojindani Site - Kamo-iwakura Site, 17.56° for Mt. Daikoku - Kamo-iwakura Site - Kojindani Site, 23.09° for Mt. Takase - Kojindani Site - Kamo-iwakura Site, and 23.05° for Mt. Takase - Kamo-iwakura Site - Kojindani Site. These angles are calculated using latitude and longitude, and there is no subjective element.

Although the reasons and circumstances for burying the bronze artifacts are unknown, it shows that a clear intention, maps, and surveying techniques existed to select the burial sites.

We consider that these are the traces of Japanese surveying techniques at the 1st century when bronze artifacts were buried. We also consider that these maps and surveying technology were used to understand the land of this province during its early creation. This paper will encourage inference about surveying methods, and the search for maps and surveying tools among ancient artifacts. We also hope that this paper will help clarify the purpose of bronze artifacts burial and the circumstances at the time.

References

[1]. Shimane Prefectural Board of Education, Asahi Shimbun, *Ancient Izumo, An Exhibition of Eternal Heritage from the Land of the Gods*, 1997, p.53, p.56, p165, p.260.

[2]. Japan Society of Civil Engineers, *Pre-Meiji Civil Engineering History*, Iwanami Shoten, 1936, p.1464, p.1468.

[3]. Takeda, M., *Surveying from ancient times to the present*, Kokon Shoin, 1979, p.3-5, p. 144-148, p.155, p.248-250.

[4]. Kimura, T., *Principles of ancient regional planning Part 1, Collection of papers on the history of civil engineering research in Japan vol.2*, Japan Society of Civil Engineers, 1982, p.83-85.

[5]. Kimura, T., *Principles of ancient regional planning Part 3, Collection of papers on the history of civil engineering research in Japan vol.4*, Japan Society of Civil Engineers, 1984, p.187-189.

[6]. Sumata, T., *Ancient Civil Engineering Techniques in the Placement of Ruins in the Kinki Region, Civil Engineering History Research Vol.10*, Japan Society of Civil Engineers, 1990, p.307.

[7]. Takebe, K., *Twenty Years of Historical Study on Civil Engineering in Japan*, Japan Society of Civil Engineers, 2000, p.6.

[8]. Kishi, T., *Ancient Japan 5 (Kinki region)*, Kadokawa Shoten, 1970, p.105-106.

[9]. Ogawa, K., *Original image of Yamato*, Daiwa Shobo, 1973, p.64-68, p.118-124.

[10]. Mizutani, K., *Unknown ancient times*, NHK Publishing Association, 1980, p.15, p.229-231, p.265, p.316.

[11]. Geospatial Information Authority of Japan, *List of mountains*, https://www.gsi.go.jp/kihonjohochousa/kihonjohochousa41140.html, 2024.

[12]. Shimane University, *Archaeological Database of Shimane*, https://iseki.shimane-u.ac.jp, 2024.