Chapter 3. Exploration Results at the Krang Kor Site

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Introduction

Using the research method of confirming information about a site in a nondestructive method helps in formulating a research plan and understanding the scope of the site, when the details of a particular site (e.g., the arrangement of artifacts) are unknown. Further, it can also provide necessary information for how to preserve the site. In conducting such research on the Krang Kor site, we were able to determine—thanks to the local residents who had found or looted objects as well as objects collected from the ground surface—that there was great likelihood that artifacts existed underground. However, because there was no history of research, and therefore no existing information on the presence or locations of artifacts, nor could any traces of artifacts be found by observing the ground surface, we determined that using physically-based investigation technique would be most effective. Additionally, we implemented the investigation on two separate occasions with the goal of having the Cambodian researchers understand, through practice and lectures, the effectiveness of this investigation technique as a way to provide a model for future research and preservation of monuments. This section will outline the investigation methods and their results. The investigation periods were November 27 through December 4, 2010 for the first survey, and July 27 through August 9, 2011 for the third survey. See Part 1, Section 2 for details of the periods.

Exploration Method

For this research, we used ground-penetrating radar (GPR). It is a way to locate abnormalities by sending electromagnetic waves into the ground from an antenna and gaging the reaction time and intensity coming from underground. The electromagnetic waves reverberate strongly against areas in the ground where there are gaps in physicality, such as difference in materials and in between geographical layers. Because it takes a shorter time and it has a higher resolution compared to other methods, it has been a highly effective method in conducting archeological surveys in Japan. Depending on the goals, the depth and resolution can be changed by selecting different frequencies of the antenna. Since this survey was being conducted overseas, there was a limited selection of devices that could be brought into the country. We used the equipment SIR-3000 by GSSI. For the antenna, we used the central frequency of 400MHz (30cm angle). The area to be surveyed was determined by setting arbitrary coordinates to establish a rectangular space within which was measured at 1-2m intervals as lines to go by. The space between the survey lines was 0.5m (Figure 1). For analysis, we used the GPR-Slice (created by Dean Goodman). A flat slice of the ground at every certain interval of depth was displayed based on the Time-Slice method using temporary profile data.

Survey Results of Zone 4

For Zone 4, in the interest of work efficiency, the survey was conducted by separating the survey zones into two parts. The maximum depth was 80ns. In the eastern section, a rectangular survey area of 16 x 49m was set up (Figure 2). Like the dot-like reflection at the Y=11m line, there are sections in which small reflections exist in circular patterns that are not related to the facilities that can be observed aboveground. The area of Y=1-31m of the survey area is an example of this. In observing the surface aboveground, there is an area around large trees where dirt has formed large mounds, and we determined that in great likelihood the circular reflection was created due to a similar situation. At the depth of 27-58ns at X=0-6m and Y=14-25m, there is a flat, circular reflection, but we believe this is due to the roots of a living tree. In the western section, we set up a rectangular survey area of 15 x 50m (Fig. 3). A strong dotted reflection is seen in a relatively shallow area, and from the depth of 13ns and beyond we were conversely able to capture a rectangular reflection at


Fig. 1 Survey is being conducted.

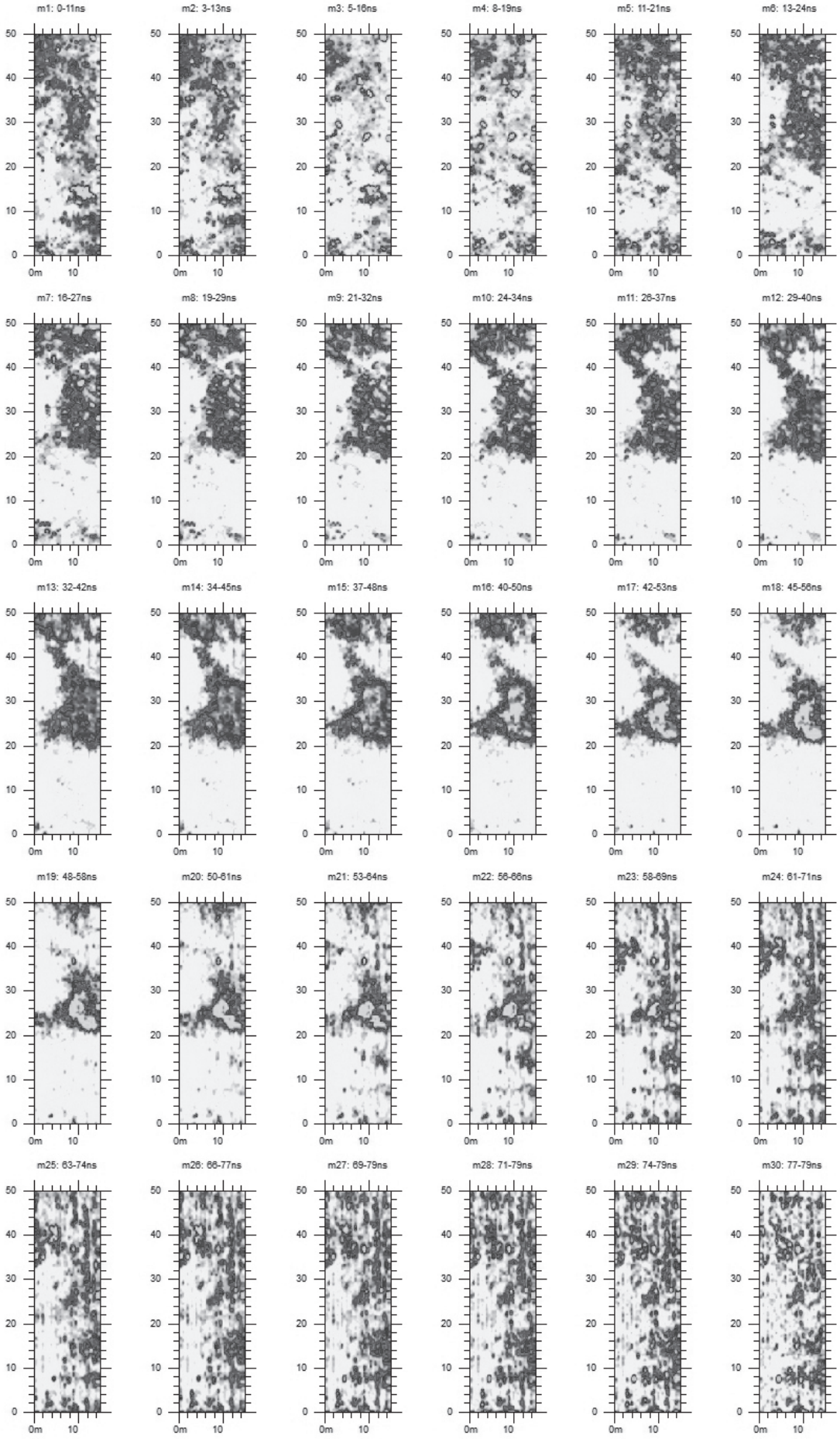

Fig. 2 Results of the GPR survey in the eastern part of Zone 4.

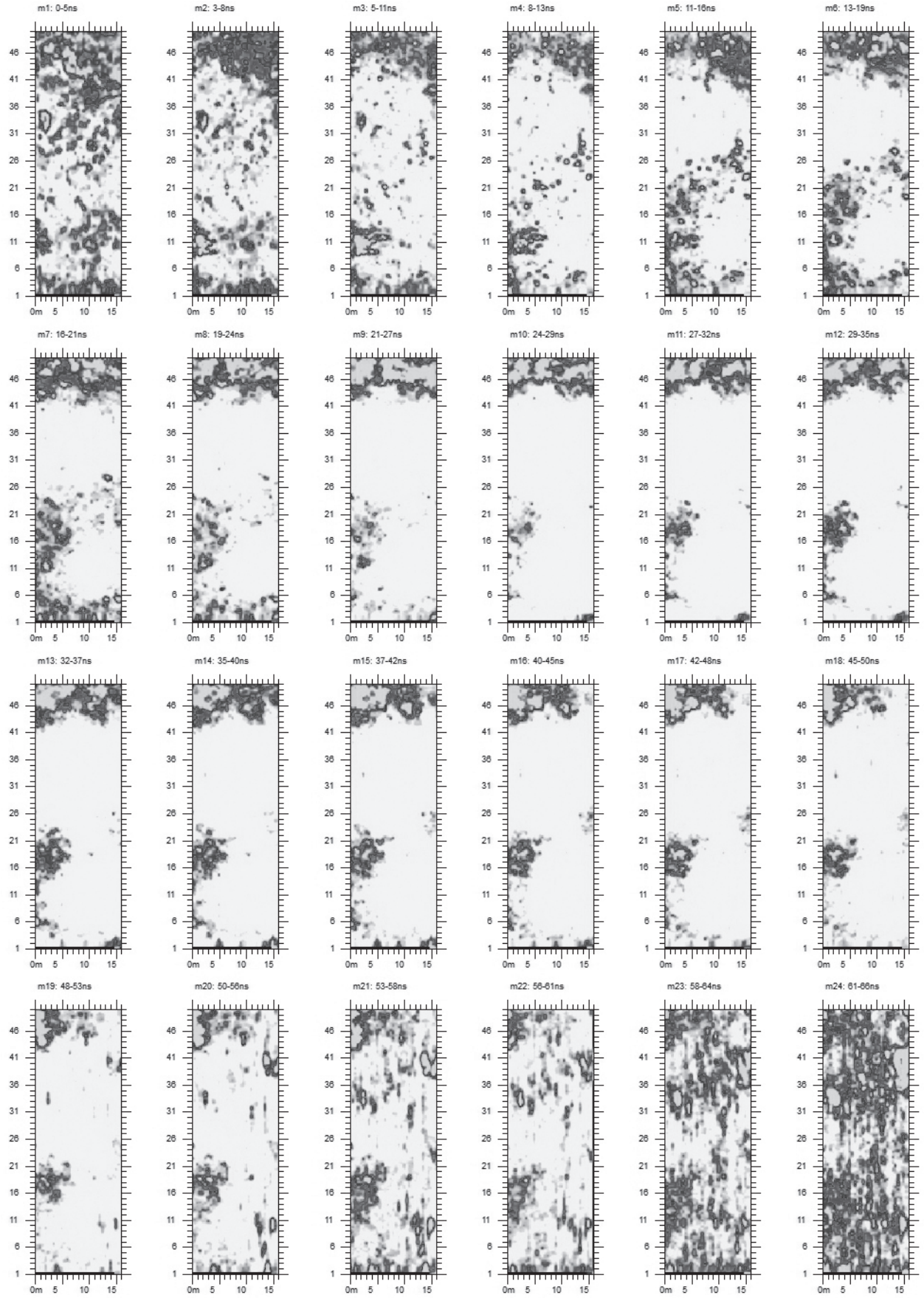

Fig. 3 Results of the GPR survey in the western part of Zone 4

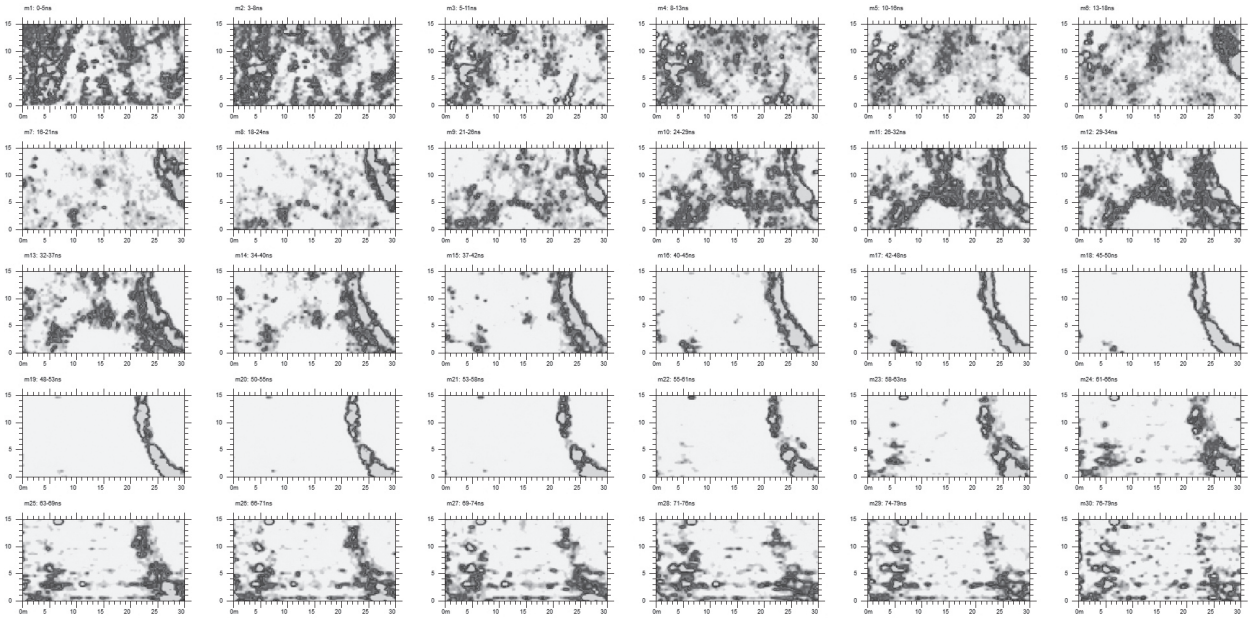

Fig. 4　Results of the GPR survey in Zone 6

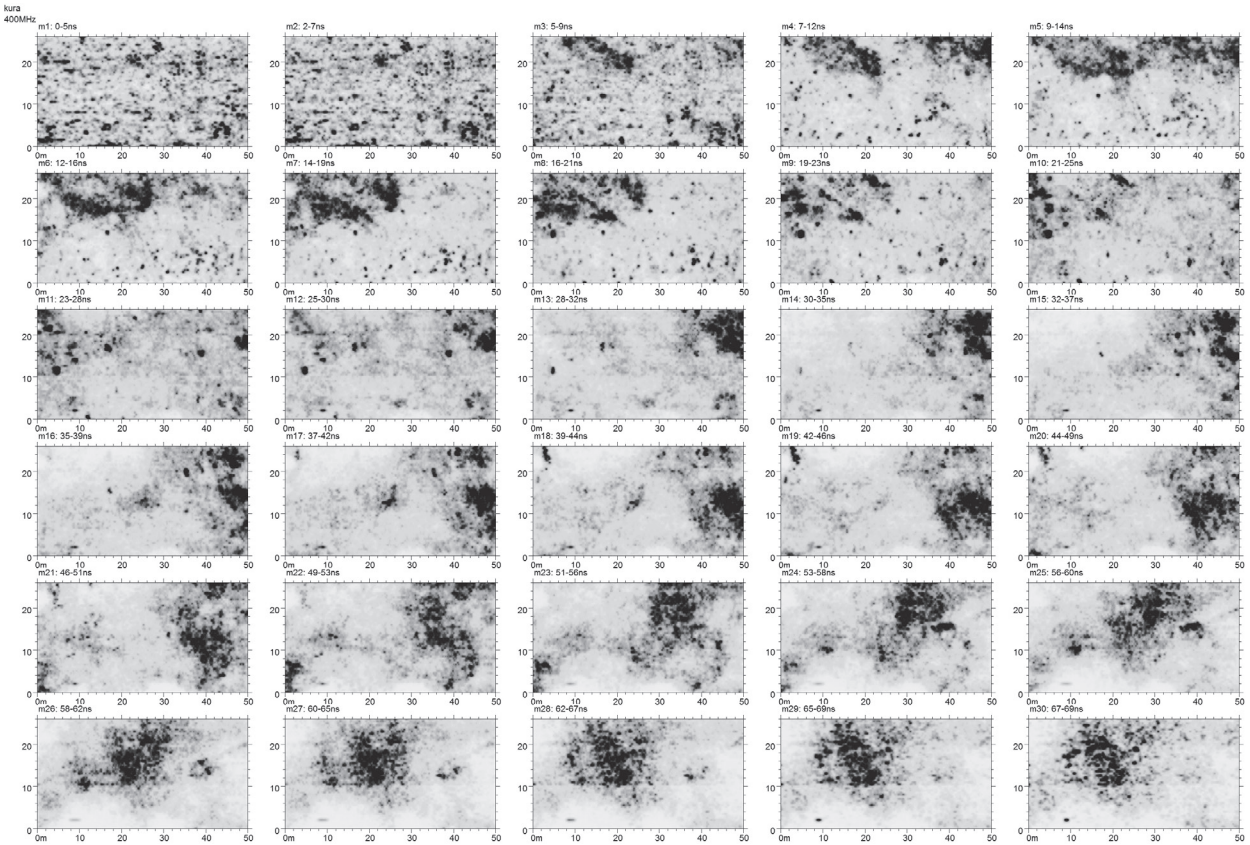

Fig. 5　Results of the GPR survey in the school zone

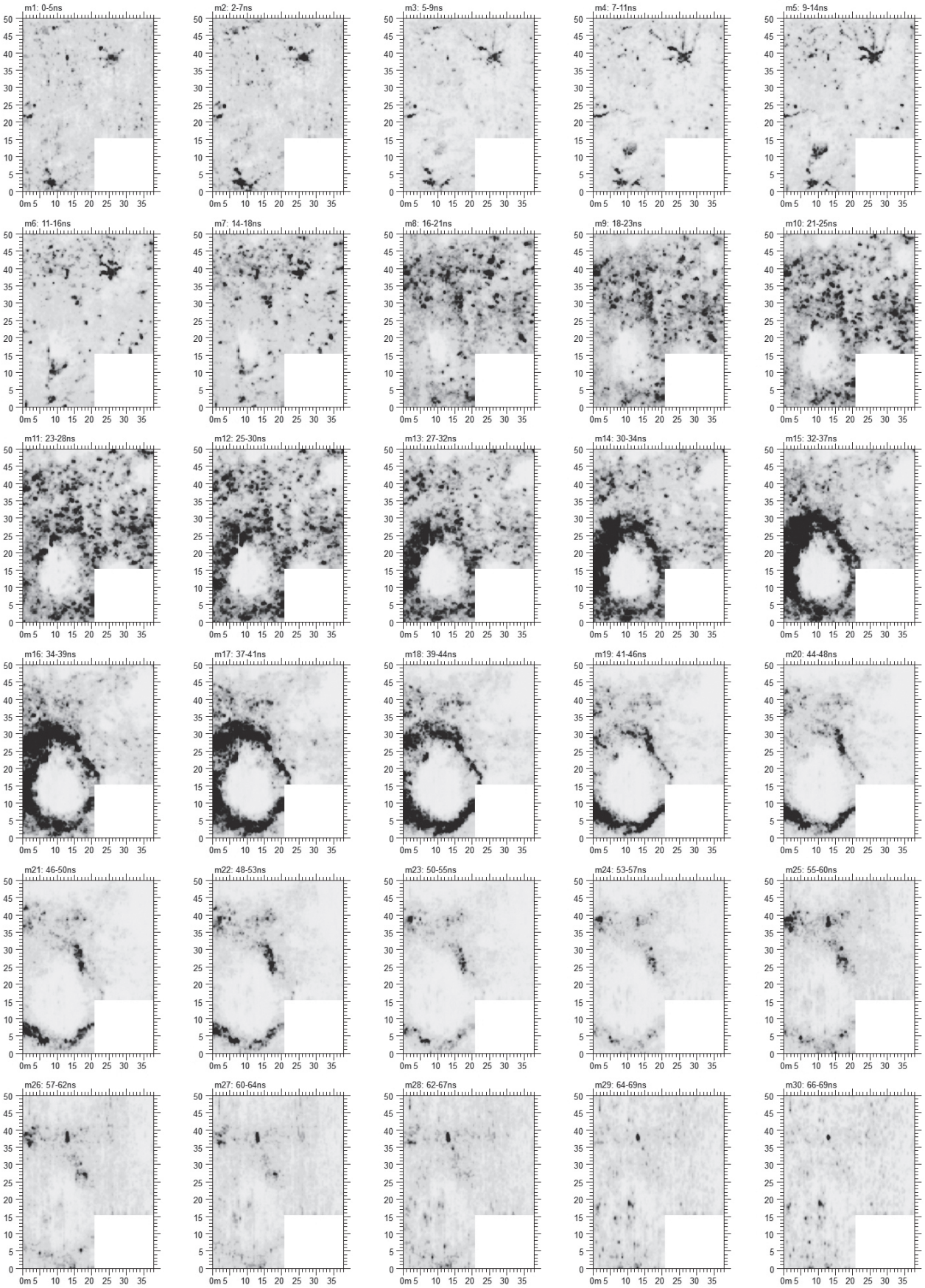

Fig. 6 Results of the GPR survey in Zone 7

X=2-15m and Y=20-40m. Looking at the details along with the profiles, we were able to detect a possible structure of some kind, and therefore, conducted an excavation by setting up a survey area. As a result, we found that the structure was a beehive.

Survey Results of Zone 6

In Zone 6 we set up a rectangular survey area of 30 x 15m (Figure 4). The maximum depth is 80ns. The first noteworthy point is the reflection that exists immediately under the grounds surface at around X=0-8m and Y=0-10m. Because bricks were found scattered in the area, we presumed there might be a small-scale architecture. Further, at X=23-30m, there was a strong reflection in the form of an arc. While we presumed the possibility of a groove or a mound-like structure, the result of an excavation proved that it was a reflection to manganese that had accumulated underground.

Survey Results of Zone 7

In Zone 7, we set up a survey area of 38 x 50m (Fig. 6). The survey could not be done in some parts of this area due to such obstructions as a fence. The maximum depth was 70ns. Most of the reflections that exist in shallow parts are mostly due to tree roots. As many parts of the survey area have a low-humidity environment, there were many places in which deposits of aggregated manganese were found. Areas with strong reflection were found in the exploration of Zone 6 as well, and as a result of an excavation, we concluded that one of the reasons for this was likely the accumulation of manganese. Therefore, it is possible that the reflections we found in this zone, too, are cause by metallic substances such as manganese that accumulate around tree roots. Areas with dotted reflections such as at X=10m and Y=11m, and at X=22-33m and Y=20m in which the possibility of the cause being roots was low, we set up a survey zone for the purpose of determining the characteristics of these reflections. Because it was possible to collect materials such as ceramics from the periphery, we determined the excavation area under the assumption that such items may have been used as an urn or burial articles. From one of the trenches, we confirmed a pit filled with carbide.

Survey Results of School Zone

In the school zone, we set up a survey area of 50 x 25m. The maximum depth was 70 ns (Fig. 5). On the eastern side, which is the side of the school, at Y=15-25m, there is a strong reflection coming from a relatively shallow place. However, because we saw that the distribution changes occurred in an irregular manner, we assumed that it is not due not to distinct artifacts, but rather, to changes in geographical formations, distribution of underground water, or accumulation of substances such as manganese. The reflection near the depth of 23-30 ns at (1) around X=4m and Y=12m, (2) around X=38m and Y=16m, (3) around X=9m and Y=14m, and (4) around X=17m and Y=17m were not reflection coming from above, and profile images of reflections that showed hollowness, which could point to the possibility of them being items such as an urn. Therefore, for (1) and (2), we set up survey areas as “A trench” and “B trench,” and conducted an excavation. Of them, we were able to confirm a Burial No.1 in (2).

Conclusion

This survey greatly differed from those normally conducted in Japan in terms of target objects and soil environment. Therefore, there was much trial and error involved as we had very little past experiences regarding the characteristics of abnormal sections underground. But by combining excavation work, we were able to gather information that need to be considered for this particular region, such as reflections due to beehives, tree roots, and accumulation of manganese. We were able to provide information that will be valid for future surveys and their interpretation. Furthermore, we were able to discover the existence of Burial No.1 as a result of our research. This, we believe, was a fruitful result as it has allowed us, together with the Cambodian researchers, to prove the effectiveness of the survey techniques in this region. In closing, we would like to express our gratitude to the residents of the local village and everyone who participated in the research.