1-1 Promotion of science and technology that supports the preservation of cultural resources

(1) Research and development for the exploration of cultural resources

Cultural resources are indispensable for us so that we have a proper understanding of the history and culture of Japan and are a base for improved development of culture in the future; therefore, it is necessary to preserve cultural resources appropriately. In order to preserve our cultural resources, it is first necessary to find them. For example, in order to detect ruins buried underground, locations where there could possibly be ruins must be predicted based on ancient writings and past excavation reports. Then, the location of the ruins is narrowed down utilizing remote sensing technology based on earth observation satellite,data and aerial photographs.

Especially remote sensing technology using earth observation satellite data is considered to be effective for exploration of ancient monuments over large areas, such as deserts or meadow plains. Actually, the discovery and excavation of an ancient Egyptian monument was successful due to this method[1].

With regard to archaeological site exploration in Japan, examples in which the abovementioned method is used are relatively few, because many things, such as cities and forests, cover the ground surface. However, the abovementioned method is extremely effective for the protection and monitoring of worldwide cultural properties, especially in this age in which environmental destruction on a world scale is a problem. Therefore, it is important that Japan should take the lead in the development and use of such technology. Moreover, Japan should also contribute to the preservation of not only Japanese but also worldwide cultural resources.

The research and development of a high-performance sensor, which has multi-wavelength and a high spatial resolution, can analyze the earth in more detail; moreover, using microwaves, it allows to observe the underground. In addition, it is necessary to construct a digital reference library of satellite observation information (digital archive) and to allot affiliate and user roles appropriately. The use and circulation of satellite observation information should be promoted.

Furthermore, after the location of the ruins has been narrowed down and before actual excavation proceeds, the state of the earth below the surface can be deduced by using ground penetrating radar (GPR), electric resistivity, magnetometry, seismic exploration, and ultrasonic exploration. Whether or not there are relics can be detected beforehand, so time and expenses associated with the excavation can consequently be greatly reduced.

"Confirmation of relic by distinguishing between different soils" is especially important for archaeological site exploration in Japan. It is more important to find stones and bricks from among the soil to be able to confirm it. In the future, it is hoped that specialists from many fields will cooperate and research a newer exploration technology. Moreover, a sensor fusion system will be developed that can explore efficiently. Ground penetrating radar (GPR), electric resistivity, magnetometry, and ultrasonic exploration will be integrated for an effective exploration.

(2) Investigation for scientific dating of cultural resources

It is extremely important that the cultural resources be genuine. If the age of a cultural resource can be accurately measured in a scientific manner, it can be determined whether the resource is genuine. In addition, it greatly contributes to the development of the chronological study in archeology[2].

Particularly, the fundamentals of cultural resources in Japan are different from those of European nations, because 'stone' is the main cultural resource at the center of European nations, while in Japan, the main cultural resources originated from organic materials such as trees and paper, and this makes it difficult to preserve cultural resources. On the other hand, however, the methods of precisely measuring the age of cultural resources, which includes radiocarbon dating, are extremely suitable and effective in Japan[3]. In addition, these technologies can be applied in foreign countries with a similar cultural resource.

In radiocarbon dating, the AMS method is frequently used, whereby radiocarbon atoms are measured directly. There is some margin of error between the radiocarbon age measured by the AMS method and the age calculated by calendar years, due to the change of past radiocarbon concentration in the atmosphere. Therefore a calibration curve is established by relating calendar ages of annual rings with radiocarbon ages of a tree, and thus the measured radiocarbon ages can be calibrated to the calendar years.

Up to now, the annual ring dating method (dendrochronology), which measures ages of cultural resources based on the data of tree ring width , and the AMS method have been used together to further increase the accuracy and precision of ages estimated for sample material[4]. It will be necessary to promote cooperation in the future so that the AMS method and annual ring dating method may mutually improve accuracy.

Moreover, a further improvement of the accuracy of the measured ages and the measurement efficiency of the AMS method will be demanded in the future. Research that enables the age determination in smaller and smaller samples is a further requirement to keep the basic principle of nondestructive analyses of resources for the sake of cultural asset preservation.

(3) Investigation regarding scientific analysis of cultural resources

A scientific analysis of cultural resources is indispensable in order to appropriately use and preserve them; however, this scientific analysis is different from usual scientific and technological research, because inevitably, the accuracy of the analysis of cultural resources tends to decrease. The causes are as follows:

1) In many cases, the materials and raw material of cultural resources are uncertain, but analysis is carried out anyway.
2) Moving a cultural resource might be difficult, so portable analysis equipment with decreased analysis performance is used.
3) It is necessary to be careful to not damage the cultural resource and to use only small amounts for analytical samples.

Therefore, the improvement and development of high-performance analysis devices is imperative in improving the accuracy of the analysis. However, the development of devices only for the analysis of cultural resources is difficult, because the market for such devices is small. Therefore, the introduction of a method for improving the accuracy of analysis is desirable, wherein the limits of the analytical equipment would be calculated either mathematically or statistically. Moreover, the development of analytical techniques applicable to cultural resources is also desirable; therefore, researchers studying cultural resources should actively participate in the development of cutting-edge analytical equipment.

The creation of a new research foundation upon which up-to-date science, and culture and the arts can be joined is particularly expected. Accordingly, the results of leading-edge science and technology research regarding the properties of materials can be applied to the preservation and application of cultural resources. Moreover, the result of the research of the microstructure of cultural resources, such as the Japanese sword, can contribute to the development of advanced technology such as super-steel.

(4) Research and development of preservation and restoration techniques for cultural resources

The next generation should inherit cultural resources, especially tangible cultural properties, which are material assets that have been inherited from previous generations. Particularly, in recent years, it has been requested that cultural resources with information that cannot be extracted or clarified with present science and technology should be preserved as much as possible without being destroyed, and they should remain intact for subsequent generations. At the same time, it has also been requested that cultural resources should be open to the public as much as possible, and they should be used culturally.

It is extremely important that these cultural resources are in fact genuine. Therefore, preservation should be considered when opening tangible cultural properties to the public, and its value as a genuine resource should be defended. The preservation/restoration of cultural resources should be advanced in this way.

Moreover, ideas for creating exhibitions with dynamism should be considered, such as in the case of the restoration of ruins, because cultural resources are used not only for the study of historical significance and value but also to increase village and cultural tourism resources.

Specifically, cultural resources are restored using methods that protect the value of the genuine cultural article, such as nondestructive inspections using radioscopy or infrared photography that is used for preliminary survey analysis, taking into consideration the cultural property's value. Basically, cultural resources are left in their "original state," and the specialists in each field gather to decide the restoration policy, thereby restoring cultural resources.

In that case, to enable on-site analysis, the development of analytical equipment that can be carried and of cleaning devices that, as much as possible, use laser instead of water is being conducted. It is necessary to concentrate on the active introduction of the research and development of the latest science and technology.

The basis is a traditional technology, but non-traditional technologies such as new technologies and raw

1: In 1996, the joint research team of Tokai and Waseda Universities succeeded in excavating the ancient ruins in Dahshur, Egypt, after discovering them by means of remote sensing technology, which uses data from earth observation satellites.

2: In May and December 2003, it was announced that the beginning of the first part of the Yayoi Period should be modified, based on the scientific analysis of a piece of earthenware, to be approximately 800 B.C., which is 400 to 500 years older than the period, according to many textbooks, believed to be the third century B.C. These research results are actively discussed among specialists.

3: In the current radioactivity measurement method, by using a sample that contains about 1 gram of carbon, the beta ray emitted in the decay of radiocarbon to nitrogen is measured in order to determine the age. However, in the AMS (Accelerator Mass Spectrometry) method, a sample with only 1 milligram of carbon is required, and radiocarbon atoms are measured directly to determine the age. The AMS method can be used for a variety of cultural resources, because of requirement of very small sample.

4: The calibration curve for radiocarbon ages measured by the AMS method is modified by the data from the annual ring dating method. On the other hand, when the chronological location of the wood splinter is unknown, its original temporal position is estimated by using the AMS radiocarbon dating method. Thus radiocarbon dating is expected to support the annual ring dating method and, in fact, contributes to the creation of a standard calendar year pattern and to extend it to older ages for dendrochronology .