

# ETCapsule 2001 PROJECT: ULTRALONG-TERM PRESERVATION OF ENVIRONMENTAL AND BIOLOGICAL SPECIMENS AND DATA

Takeharu Etoh<sup>1</sup>, Toshikazu Shibata<sup>2</sup>, Makoto Watanabe<sup>3</sup>, Koji Muraoka<sup>4</sup>,  
Toichi Okada<sup>5</sup>, Okitsugu Watanabe<sup>6</sup>, Chisato Okazaki<sup>7</sup> and Atsuko Hanashima<sup>8</sup>

## Abstract

An environmental time capsule, or ETCapsule, which will retain samples and data for an ultralong period is covered in this report. The samples will serve as fundamental data for researchers in the distant future. We plan to seal the ETCapsule at 00:00, January 1, 2001 on the top of the Dome Fuji, 3,800 m above sea level, in the antarctic continent.

This report summarizes research in the basic study phase, which contains (1) classification of existing storages of biological and environmental specimens, (2) comparison of major past time capsule, (3) a proposal of a new time capsule for biological and environmental specimens, based on the classification and comparison, (4) basic strategies for sampling and selection of samples, (5) brief explanation on meteorological and ice cover conditions of Dome Fuji, and (6) time schedule of the project to the year of 2001.

**KEYWORDS:** *time capsule, environmental specimen, biological specimen, ultralong period, preservation*

## 1. Introduction

This report introduces an environmental time capsule, or ETCapsule, which will retain samples and data for an ultralong period. The samples will serve as fundamental data for researchers in the distant future. For this purpose, it would be ideal if it were possible to preserve actual samples together with written records describing the earth's living things and their environments. We hope to seal the ETCapsule at 00:00, January 1, 2001 - at the end of the 20th century and the beginning of the 21st century on the top of a dome in the antarctic continent. It will be a good opportunity to leave the environment of the 20th century earth for people in later centuries.

This report covers various aspects and problems associated with such long-term storage and describes the related studies we have made.

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- 1 D. Eng., Professor, Dept. of Civil Eng., Kinki University, Kowakae, Higashi-Osaka 577 Japan.
  - 2 D. Eng., Professor, Director, Atomic Energy Institute, Kinki University, Japan.
  - 3 D. Sc., Chief, Environmental Microbiology Laboratory, Nat. Inst. of Environmental Research, Japan.
  - 4 D. Eng., Professor, Chairman, Dept. of Civil Eng., Osaka University, Japan.
  - 5 D. Eng., Professor, Director, Institute of Scientific and Industrial Research, Osaka University, Japan.
  - 6 D. Sc., Professor, Nat. Inst. of Polar Regions, Japan.
  - 7 D. Eng., Formerly, Matsushita Electric Industry Co., Ltd, Japan.
  - 8 M. Eng., CKS Institute Co., Ltd, Japan.

Table 1.a Examples of preserved samples useful in environmental research

Intentionally-preserved samples	For environmental research	Organized preservation	Environmental specimen banks (ESB)	See Table 1.b
			Regional and/or special purpose preservation	For special diseases, specific lakes, etc.
		Personal preservation	Fat samples of sea mammals, river/lake water samples, rainwater samples, earth core samples, dust samples, etc.	
	For general or other purposes	Organized preservation	Specimen banks	Seeds, microorganisms, blood, germ cell banks, etc.
			Museums	Dried samples (stuffed animals and birds and eggshell, etc.), mummies
			Botanical gardens and zoos	Plants and animals
			Medical schools and authorities	Human tissue, microorganisms, etc.
			Food authorities	Food samples
			Preserved areas	National parks, sanctuaries, etc.
	Personal preservation	Human hair or rice grains dedicated to shrines, ancient artifacts, fibers, leather, etc.		
Naturally-preserved samples		Ice cores, lake beds, old blocks or chips of wood, etc.		

Table 1.b Examples of environmental specimen banks (ESB)

Nation	Organization	Samples	Temperature (°C)	Duration (years)
Germany	ESB, Jülich, KFA	Environmental samples (fish, leaves, etc.)	-80 -140	50 - 100
	Umweltprobenbank für Human Organproben mit Datenbank, Münster	Human tissue (blood, urine, organs, etc.)	-80	50 - 100
USA	ESB, National Institute of Standards and Technology	Environmental samples (seals, etc.) and human tissue (human liver samples)	-140	100 - 200
Japan	ESB, National Institute of Environmental Research, Japan	Environmental samples, human tissue and food	-20 -80 -196	50 - 100

## **2. Examples of long-term storage of biological and environmental specimens**

Biological and specimen banking and monitoring is very important. For example, the fact that the recent increase in the amount of PCBs in nature is attributable to human activities was discovered by the analysis of the feathers of stuffed white-tail eagles stored at the Swedish National Museum.

Samples are stored for different periods and subject to different monitoring methods depending on the purpose. Some institutes and researchers have stored environmental samples and some public organizations have announced storage and monitoring plans (see Table 1). The longest period of 100 to 200 years is that of human liver storage by the National Institute of Standards and Technology, U.S.A., while the remaining plans are for several tens years.

Preservation for terms exceeding hundreds of years is also important. For example, analysis of ice cores from the Antarctic helps us track changes in carbon dioxide concentration back over several tens of thousands of years. There is also a project to analyze DNA from Egyptian mummies. From looking at the results of long-term preservation in nature, and realizing what it offers us, we think it reasonable to take a natural step forward and intentionally preserve environmental samples (including living things) that describe the current earth environment for future generations of researchers.

Since we started work on this ETCapsule project which intends to preserve biological and environmental specimens for an ultralong period under natural conditions in the earth's coldest place, people in Germany and the U.S.A. who have already started to preserve such specimens at low temperature under artificial conditions have shown interest in the project. This is because they realize that political and social changes could threaten the preservation method itself if it uses man-made techniques and facilities.

## **3. Existing and Proposed Time Capsules**

### **3.1 Comparison of existing time capsules**

We have compared three scientific capsules: time capsules I and II buried by Westinghouse Electric & Manufacturing Company during the 1938 and 1965 New York World Fairs when the term "time capsule" was coined; and those buried during Osaka EXPO '70 by Matsushita Electric Industrial Co. Ltd. and The Mainichi Newspapers. Fortunately, we have official records of these capsules as well as related information on capsules I and II collected at the time of the New York World Fairs (see first three references). We have collected information related to these time capsules and condensed it into Tables 2 to 6.

Photo 1 shows Time Capsule I and the official record prepared in 1938 by Westinghouse. This torpedo-shaped time capsule is made of cupaloy and measures 229 cm in length and 21.3 cm in diameter. The official record contained messages to discoverers 5,000 years in the future not only in English but also using pictorial symbols and more than 3,000 copies were distributed to libraries and other organizations around the world.

The two Matsushita time capsules were buried one on top of the other; the one on the bottom is destined to remain sealed for 5,000 years while the one on top will be opened for monitoring at the turn of each century. We find this a very wise approach.

We are also in contact with the persons responsible for the EXPO '70 time capsule to obtain unofficial, detailed information on discussions and studies which took place at that time.

Our comparison of these capsules is based mainly on the official records and the results have been listed in the five tables which provide us with our primary data: what subjects were selected and studied during the planning phase of each time capsule, the background of each of these world fair years and the differences in technical levels between these times, and the changes in themes of these capsules.

### 3.2 Planned scope of the ETCapsule

#### (1) Background

##### (a) Theme

Placed beside the Beatles' record in the 1965 time capsule II are a Mercury heat shield after reentry and graphite from a Fermi reactor, symbols of the rapid progress of humankind since the burial of Time Capsule I in 1938: see Tables 2 and 3. If we regard the ETCapsule as the follow-up of the 1970 Matsushita-Mainichi time capsule, what are we to select as samples to represent human progress from 1970 to 2001? The most significant progress will be found in environmental and life sciences.

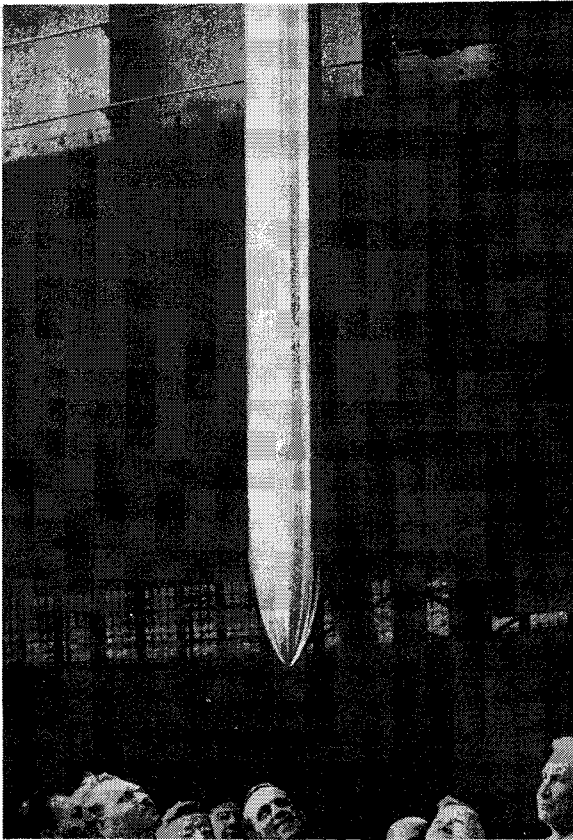


Photo 1. Time Capsule 1 and its Official Record by Westinghouse Electric & Manufacturing

Table 2. Comparison of existing time capsules - (1) General description

	Time capsule I	Time capsule II	Time capsule EXPO '70
Triggering event	New York World Fair (1938-1939)	New York World Fair (1964-1965)	Osaka EXPO '70: 50th anniversary of Matsushita Electric Industrial Co., Ltd.
Sponsors	Westinghouse Electric & Manufacturing Company	Westinghouse Electric & Manufacturing Company	Matsushita Electric Industrial/Mainichi Newspapers
Date of burial	At noon, Sept. 23, 1938 (autumnal equinox) before the NY World Fair.	Oct. 16, 1965 after the NY World Fair II	Capsule No. 1: Jan 20, 1971 Capsule No. 2: Jan 28, 1971 (after EXPO '70)
Date of authorization	Early in 1938		Dec. 1, 1967
Planned preservation period	5,000 years	5,000 years	5,000 years
Reason for the period	Mankind has a 5000-year recorded history and the capsule is a monument buried at the midpoint of history as viewed from the 70th century.		Mankind has a 5000-year recorded history and the capsule is a monument buried at the midpoint of history as viewed from the 70th century.
Steering committee	Engineers of Westinghouse Electric & Manufacturing Company; scientists and researchers.	A committee comprising 14 experts in various fields. The chief of the committee was Dr. Leonard Carmichael (vice-president for research and exploration, National Geographic Society).	EXPO '70 time capsule committee and subcommittees: Technical committee – Seiji Kaya (chief) and 22 scientists and experts; Selection committee – Shiro Akabori (chief) and 28 members.
Major subjects studied	1) Means to ensure 5000-year preservation. 2) How to leave records showing the location of the capsule. 3) Selection of the contents.	Selection of the contents.	1) Selection of the contents. 2) Techniques for 5000-year storage.
Cost			Direct cost was approx. 0.2 billion yen (1.6 million US dollars).

Table 3. Comparison of existing time capsules - (2) Storage technique

	Time capsule I	Time capsule II	Time capsule EXPO '70
No. of capsules	1	1	2
Shape of container	Torpedo-shaped.	Torpedo-shaped.	Spherical.
External dimensions	Length: 7½ ft (229 cm) Diameter: 8¾ in (21.3 cm)	Length: 7½ ft (229 cm) Diameter: 8¾ in (21.3 cm)	Diameter: 106 cm
Internal dimensions	Length: 6 ft 9 in (206 cm) Diameter: 6¾ in (16.2 cm)	Length: 6 ft 9 in (206 cm) Diameter: 6¾ in (16.2 cm)	Internal diameter: 100 cm Internal capacity: 500,000 cm <sup>3</sup>
Total weight	800 lbs (363 kg)*	300 lbs (136 kg)*	2.12 tons
Container material (exterior)	Cupaloy (copper 99.4%, chromium 0.5%, silver 0.1%).	Kromarc (super alloy).	NTK-22AT (special stainless steel: nickel 22%, chromium 20% and titanium).
Criteria for material selection	Can be forged to a strength equal to steel and is highly corrosion-resistant like copper.		It is an austenitic steel and an alpha phase transformation does not occur during mechanical processing.
Casting of container	Container consists of 7 individually-forged sections.	Container consists of 3 individually-forged sections.	Container consists of 2 individually-forged sections.
Items excluded from sampling plan	Volatile, acid-generating and liquid materials (can affect other materials).		Pathogens, etc.
Partition between contents	Seeds: sealed glass bottle. Film: aluminum container. Others: individually wrapped with rag paper and bundled with hemp string.	Seeds: sealed glass bottle. Film: aluminum container. Others: individually wrapped with rag paper and bundled with hemp string.	29 stainless steel inner containers.
Packing practice	Heavier samples at bottom, film cartridge and then lighter samples, e.g. lady's hat, at top.		The contents were sterilized either by heat, ethylene oxide gas or gamma rays.
Sealing	Omitted here for reasons of space		
Capsule's internal environment	Filled with nitrogen gas with moisture at normal R.H.	Filled with nitrogen gas with moisture at normal R.H.	Filled with dry argon gas.

\* The reason for this difference is unknown.

Table 4. Comparison of existing time capsules - (3) Selection of samples to be stored

	Time capsule I	Time capsule II	Time capsule EXPO '70
Selection criteria	Things representative of 20th century life	Things representing progress in civilization in the 25 years from the time of Time Capsule I.	Typical goods representing modern civilization and documents: up-to-date samples; Japan-based; actual items in preference to explanatory documents or pictures.
No. of contents	112 pcs (including 1 roll of microfilm containing 304 items, 1 newsreel containing 11 items).		2098 pcs
Major contents	Daily commodities, clothes, materials, seeds, books, money, microfilm (copy of documents), newsreel.	Microfilm, film, bikini, transistor radio, ball-point pen, automatic camera, electric tooth-brush, electronic circuit.	Electronic devices, metal materials, new materials, papers, recording tapes, medical and biological samples, garments, contraceptives, materials recording manners and customs, photographs, microfilms.
No. of major items	The microfilm contains information the equivalent of 100 books (22,000 pages).	475 materials, the microfilm contains 117,000 pages.	Natural science: 742 pcs Social science: 686 pcs Art: 592 pcs Others: 78 pcs
Topics	Newsreel containing a speech by F.D. Roosevelt, fashion show in Miami.	A Beatles' album, graphite from the world's first nuclear reactor, a Mercury space capsule heat shield after reentry.	Pure iron.
Biological and environmental samples	Seeds (wheat, corn, oats, tobacco, cotton, flax, sugar beet, barley, rice, soy beans, alfalfa, carrots).	The microfilm descriptions include the discovery of DNA and RNA, new vaccines at that time, and organ transplants.	Phages, bacteria, DNA, enzymes, useful microorganisms, seeds, mosquitos and flies.
Instruments	None.	None.	Plutonium atomic clock, maximum/minimum thermometers.

Table 5. Comparison of existing time capsules - (4) Burial site

	Time capsule I	Time capsule II	Time capsule EXPO '70
Burial site	Under the NY World Fair pavilion (now Flushing Meadow).	Ten feet north of Time Capsule I.	Osaka Castle Park (historic spot).
Coordinates	40° 44' 34.089"N, 73° 50' 43.842"W	40° 44' 34.089"N, 73° 50' 43.842"W	34° 40' 58.526"N, 135° 31' 42.718"E
Altitude	Approx. 20 ft (approx. 6 m)	Approx. 20 ft (approx. 6 m)	32.159 m
Depth	50 ft (approx. 15 m) underground.	50 ft (approx. 15 m) underground.	14.37 m (Capsule I) and 9.5 m (Capsule II) underground.
Reason for the location	After 5000 years, New York would be a historic site like Athens, Rome and Troy.		The place is officially designated as a special historic spot and is protected against reconstruction and destruction.
Geology, stratum	Swampy soil. Although settlement of the East coast is forecast, it will only be several feet after 5000 years. Contains almost no chlorine ions that cause metal corrosion.		In the clay piled 300 years ago over diluvial formations. Temperature in the clay is a consistent 17±0.1°C throughout the year.
Structure of capsule system	The foundation is a water-tight cement block onto which the capsule was placed through a 10-inch diameter steel pipe. The capsule was covered with concrete and resin. The steel pipe was cut off and then removed.		Capsule I was sealed in a stainless steel cylindrical burying pipe which was then covered with a protective concrete cap. Capsule II was buried in almost the same way as Capsule I but covered with slightly thinner concrete.

Table 6. Comparison of existing time capsules - (5) Official documents and follow-up system

	Time capsule I	Time capsule II	Time capsule EXPO '70
Form of document(s)	3,650 copies of a book "The Time Capsule".	A sheet of paper to be attached to the documents of Time Capsule I: "Deposit of Time Capsule II".	"The Official Record of Time Capsule EXPO '70" in English. Two volumes of official records on the project in Japanese.
Size and covering	25.6 × 16.2 × 1.2 cm, 52 pages (2,000 copies with softcovers; 1,650 copies in buckram).	A sheet of paper, 20.0 × 13.8 cm.	30.3 × 21.7 × 3.5 cm with black cloth covers (2,000 copies of the English version).
Languages used	English and instructions describing the deciphering method for English, in case English is an extinct language in 5,000 years time.	English.	English and Japanese versions. Inside the capsule there is a miniature Rossetta stone having messages written in seven official languages of the United Nations.
Contents	Purpose of the time capsule. Locating methods (three different ways). How to understand English (19 of a total of 52 pages). Messages to people 5000 years in the future from Robert Millikan, Thomas Mann and Albert Einstein.	Burial location, criterion for sample selection and contents.	1) Description of Time Capsule; 2) Procedure for unearthing; and 3) List of contents.
Distribution	Libraries, museums, temples, and other places considered "safe" in every respect, all over the world.		Japanese version: Libraries, museums, universities, etc. in Japan. English version: Libraries overseas.
Follow-up system			Capsule I will be opened after 5,000 years. Capsule II will be opened every 100 years at the beginning of each new century.

#### (b) Selection, collection, storage and preservation period of samples

Since the ETCapsule will be a monumental event at the beginning of the 21st century, suitable storage periods will be one thousand years (to the 31st century) or eight thousand years (to the 101st century). Because the project will employ a natural storage method, and many samples will require low temperatures for storage, one possible burial location would be within a polar circle.

### 3.3 The proposed capsule

It is proposed, therefore, that the ETCapsule should be filled with environmental and biological specimens and data, and then buried somewhere in a polar region for retrieval in 1,000 or 8,000 years.

## 4. Sampling and Storage of Samples

### 4.1 Biological samples

Freezing, freeze-drying (lyophilizing) and drying are all methods capable of preserving organisms or parts of them while retaining the life or biotic potential. Of these, freeze-drying and drying have been successfully applied only to bacteria, germs, fungi and some kinds of seeds, and the period of preservation is limited to at most several tens of years with increasing death rate. Freeze storage at  $-80^{\circ}\text{C}$  and below can keep them alive for a very long time. So, to store life for ultralong periods, employment of freeze storage around  $-80^{\circ}\text{C}$  under natural environmental conditions should be considered.

### 4.2 Environmental samples

First, we must determine the selection criteria of samples suitable for ultralong storage. Samples commonly studied in the environmental science field as listed in Table 7 are possible candidates. Generally, these can be divided into two groups: environmental and biological. Dead biological samples are regarded as environmental ones. Live biological samples that serve as index organisms can also be regarded as environmental samples because their habitat can be determined by their analysis; they can also be used as a contamination index.

### 4.3 Basic criteria for sample/information selection

We propose an optimum combination of samples and information, to maximize the density of information stored in the limited capacity of the environmental time capsule. The concept is explained below, taking DNA as an example of an essential biological sample.

The history of a creature is condensed in its DNA. In the distant future, it may be possible to produce clones using only the information contained and preserved in DNA. There is no man-made memory device that can carry such a huge amount of information as DNA in the same space. For example, the DNA contained in a single human genome has approximately 3 billion base pairs in a 0.01-mm-diameter cell nucleus.

Table 7. Typical environmental samples that may be preserved for an ultralong period

Air	Precipitation (rain, snow) Fine grain (airborne, fallen) Gas
Water	Seawater (ocean, coastal) Fresh water (lake, pond, river, underground)
Soil	Soil (city, forest, arable land)
Benthic soil	Benthic soil (marine, lake, river)
Organism (dead sample) (Index organism)	Plants Land (large, moss, seed) Water (large, lemnaeae, plankton) Animals Air (birds, insects) Land (large, small, insects) Underground (small, insects) Water (fish, insects, plankton) Benthos
Human body	Body fluids (blood, urine) Organs Hair, nails, teeth

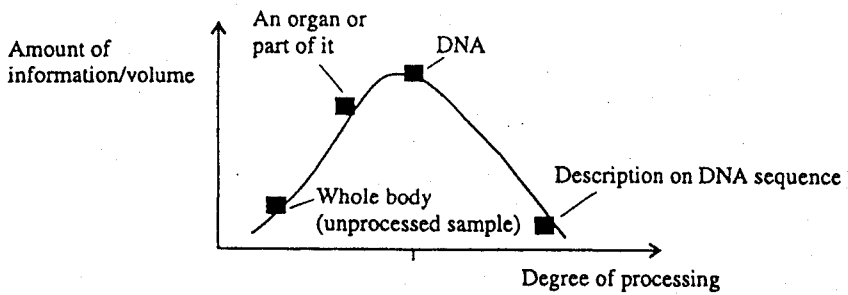


Figure 1. Relationship between degree of processing of samples and amount of information per unit volume

According to the degree of processing of organic material, there are some alternative biological samples which could be stored: the whole body of a creature; a specific organ of the creature which may contain dense information; DNA, and a description of DNA sequences.

Among the alternatives, DNA may contain the maximum information per unit volume, since DNA is much smaller than any current artificial memory device which could record the whole description of its sequence. This is conceptually depicted in Fig. 1. DNA has a further advantage - it is a chemically stable material. Consequently, it may be concluded that DNA is the best candidate to be selected as the core of the living samples.

There are important messages that are not described in DNA. Among them is the life history of a creature; for example, physical deformations (crooked or broken bones, etc.) acquired during its life.

There are other organs that contain important information. One typical example is the brain whose molecular structure and composition could be used to play back memory and emotion when the ETCapsule is opened. These organs should be preserved directly.

To pack the maximum of information on a given organism into the limited space inside the time capsule, a set of materials should consist of DNA (the core sample) together with samples of the organisms themselves and supplementary documents. This concept of maximum information, i.e., the set of core samples with dense information and supplementary samples and documents, may also be applied to environmental samples. It is important that the selected environmental samples are representative in all respects. Both biological and environmental samples and data should be logically linked to reason the selection of a set of particular samples and data. In addition to the above, documents, tables and drawings which have been included in conventional time capsules are effective media which preserve illustrative information for the future.

#### 4.4 Worldwide simultaneous sampling

The environmental time capsule is to contain things that preserve the environmental state (such as sea water, air, land) of the 20th century. The selection of specific samples should be made after further results from related research. The means and locations of sampling are also under study. One preferable plan is to collect samples all over the world in a standardized way and at the same time.

#### 4.5 Short, medium and long-term preservation

One-third of the simultaneous worldwide samples are to be immediately analyzed to describe the earth environment at the time of sampling. Another one-third are to be stocked under artificial management and analyzed as additional data becomes necessary (in time units of 10-100 years). Selected samples from the remaining one-third are to be stored in the environmental time capsule (1,000 years or 8,000 years).

Since the environmental time capsule will be recognized as an international event, quarantine barriers against the importation of materials (water, soil, etc.) could be lifted. The use of radiation or the addition of chemicals for sterilization will not then be required, and the preservation of the original state of the sampled materials can be assured, which will be essential to accurate central analysis of all samples under the same conditions. In this way, the time capsule project will facilitate the advancement of science, not only for the purpose of the ultralong-term time capsule, but also for short- to long-term progress.

## **5. Preservation in polar regions**

### **5.1 Ice cover movement**

Thick ice abounds in Antarctica, Greenland, in glaciers, and in permafrost. The ice moves constantly at rates from 10 m to 2 - 3 km/year. Fortunately, around the area where Dome Fuji (F) is located near the south pole (Fig. 2), the movement is very slow in both horizontal and vertical directions (Fig. 3). An ice-core borehole is currently being drilled at Dome F by a team organized by Professor Okitsu Watanabe of the National Institute of Polar Regions of Japan, who is also on the ETCapsule committee, to investigate long-term changes in the earth's atmosphere (Watanabe, 1994). Drilling of the hole was started in 1994 and is to be completed by 1998. When finished, it will be 2,500 meters deep with a diameter for the top 300 meters of 30 cm and for the remainder of 10 cm. Therefore, if the ETCapsule is to be buried in the hole at Dome F, it must be torpedo-shaped with a diameter of 30 cm or less, just like the ones made by Westinghouse Electric & Manufacturing (Photo 1). Dome F is currently the best candidate storage site for one of the ETCapsules due to the reasons explained below.

### **5.2 Reasons for choosing Dome F**

#### **(1) Average temperature**

At Dome F, the average temperature is below  $-60^{\circ}\text{C}$ , close to  $-80^{\circ}\text{C}$ , the critical level where living organisms could be kept frozen for a long time and remain viable. To our advantage, the annual temperature variation is negligible 10 meters below the ice cover surface.

#### **(2) Ice movement**

As can be seen from Figs. 2 and 3, at Dome F ice cover movement is negligibly slow, both horizontally and vertically with temperatures lower than  $-60^{\circ}\text{C}$ . It would be possible, therefore, to use the borehole to bury the capsule a few tens of meters below the surface of the ice cover, in consideration of the possibility of the ice evaporating or melting.

#### **(3) Precipitation**

According to the measurement of radioactive material contained in the ice as a result of past atmospheric nuclear defonation tests, the annual average precipitation around Dome F is about 32 mm. This means anything buried in the ice would sink only 32 meters in 1,000 years, and recovering the buried time capsule would be comparatively easy.

#### **(4) Transportation and accommodation**

Transportation to Dome F already exists and accommodation is available thanks to the borehole drilling project, itself an international event.

#### **(5) Legal approval**

Permissions from and consensus among countries are also necessary to bury the capsule at the south pole.

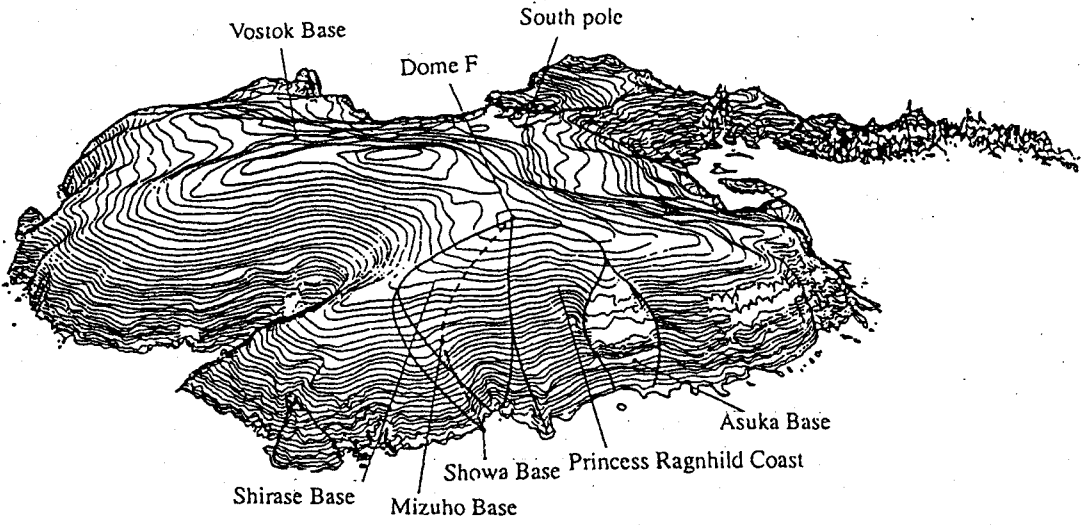


Figure 2. Bird's eye view of observation bases on Antarctica around Dome F

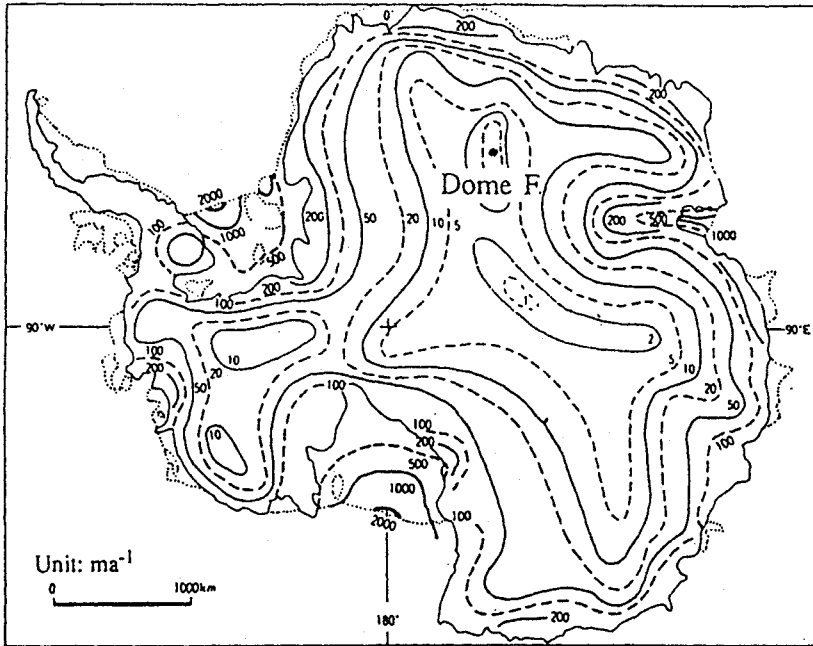


Figure 3. Balanced velocity distribution of the Antarctic ice cover (Budd, et al., 1971)

### 5.3 Dimensions of the ETCapsule

The ETCapsule will be torpedo-shaped if it is to be buried in the drill hole at Dome F. Tentatively we have decided on a capsule 2 meters long by 25 cm in diameter. The diameter must be less than 30 cm because the hole at Dome F has a diameter of 30 cm, as mentioned in subsection 5.1. Since the time capsule will have to be carried on a snowmobile, this defines the maximum length of 2 meters. We plan to carry one capsule to Dome F first. If some environmental organizations or specimen banks showed interest in joining our project, there may be up to a few tens of additional time capsules. No problems are expected from transportation because the hole will be already there and transportation will have been established.

Sets of the specimens included in the time capsule will also be reserved in the original countries or institutions for short- and medium-term monitoring.

## 6. Project schedule

Since the establishment of a small project team at Kinki University in 1989, we have engaged in basic study over the past six years. We show all the operations necessary to realize the ETC project in Figure 4 to 6.

This project, first mooted in 1989 by a small group of people, has almost reached completion of the basic study phase and is now entering the second stage. There is still a lot to do in the coming five years.

Besides other studies and preparations, we have been expanding our human network to promote the project. The project is now financially supported by the Japanese Ministry of Education.

## 7. Concluding Remarks

The project to bury time capsules for biological and environmental specimens has been introduced. As a large-scale project like this cannot be implemented by a single academic institution or even by a single country, international cooperation will be indispensable in all stages of the project from sample selection to preparation of a follow-up monitoring methodology.

The initial research associated with this project has been supported for 1994 and 1995 by Grant-in-Aid (No. 06302084) from the Ministry of Education of Japan.

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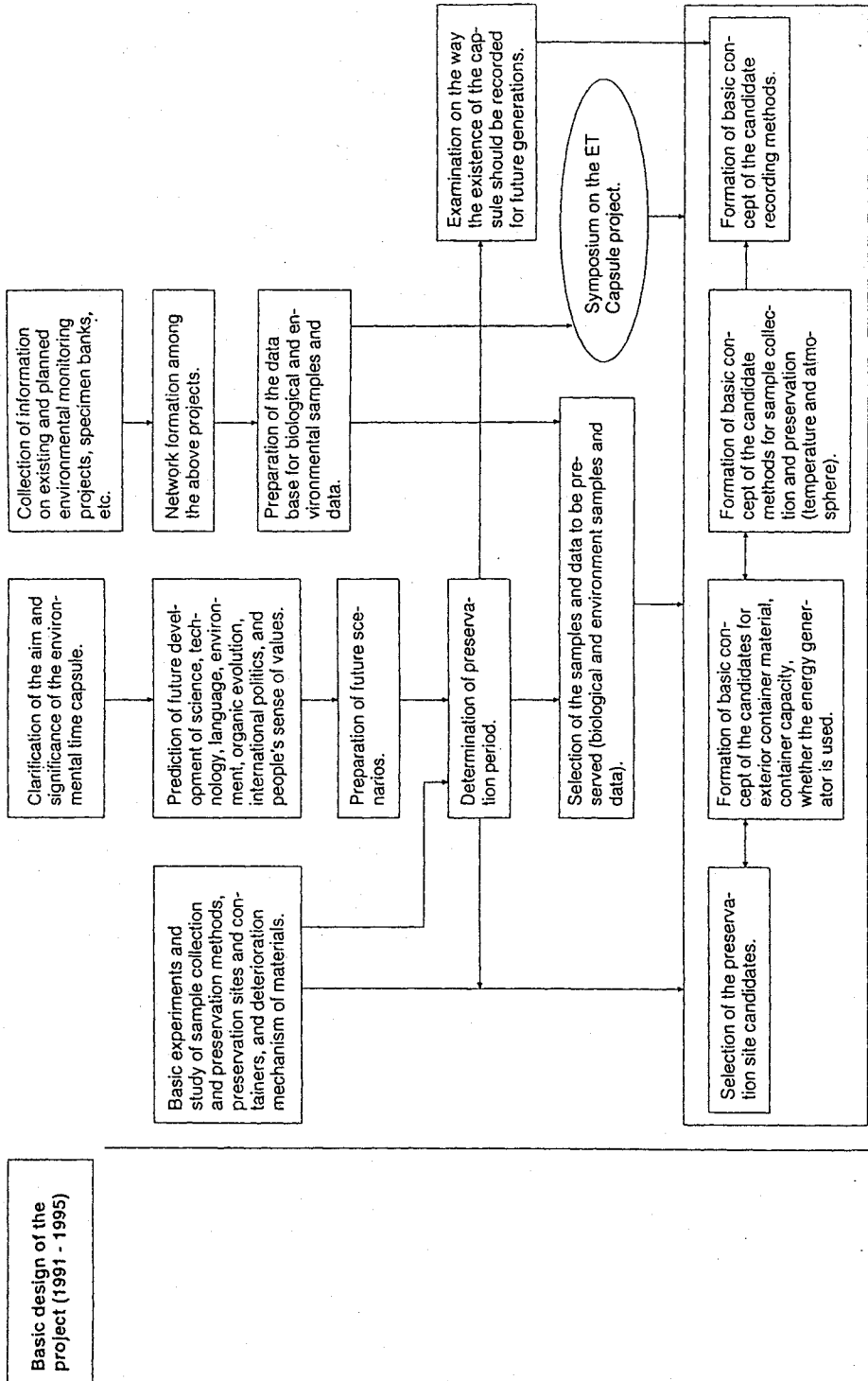


Figure 4. Project schedule 1

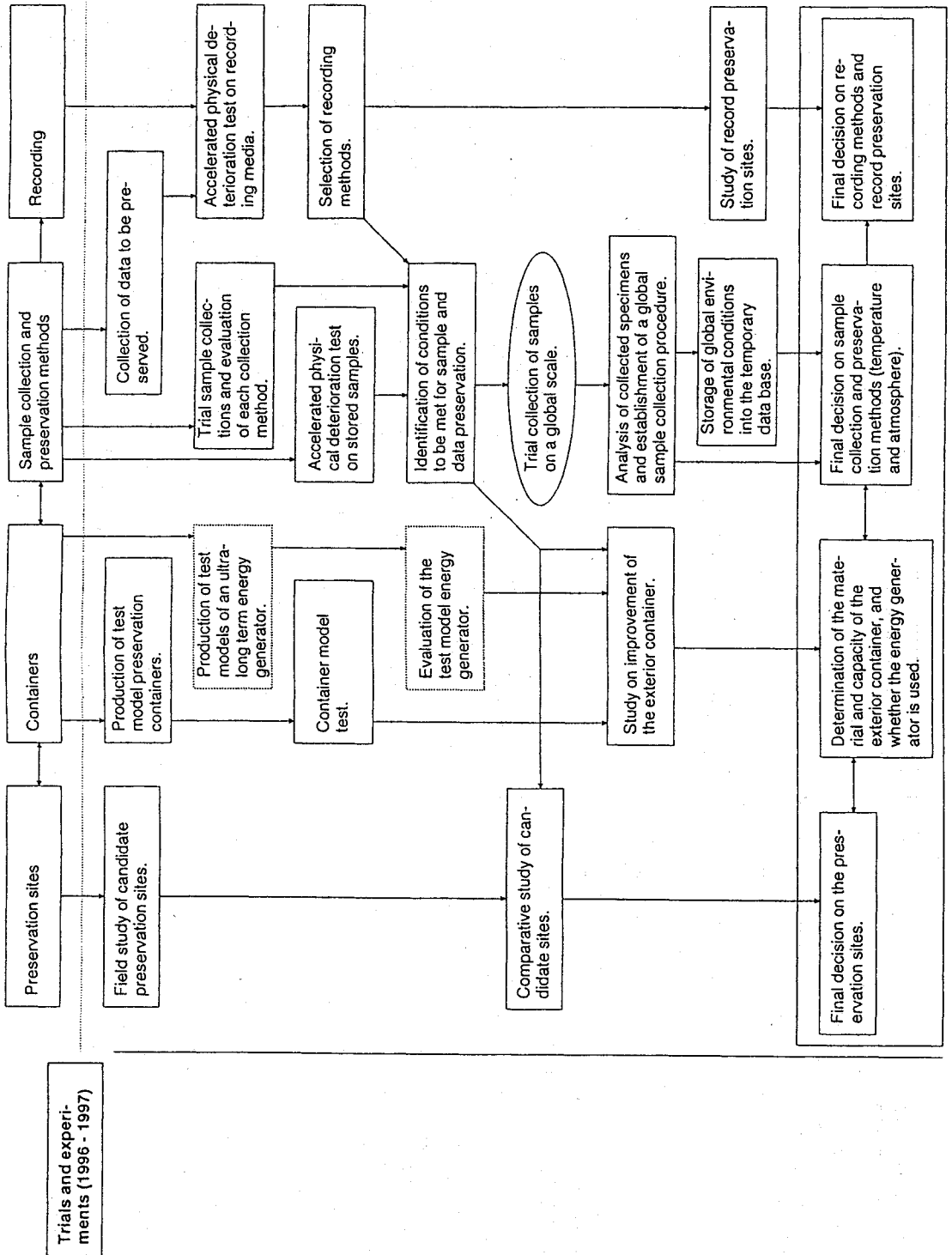


Figure 5. Project schedule 2

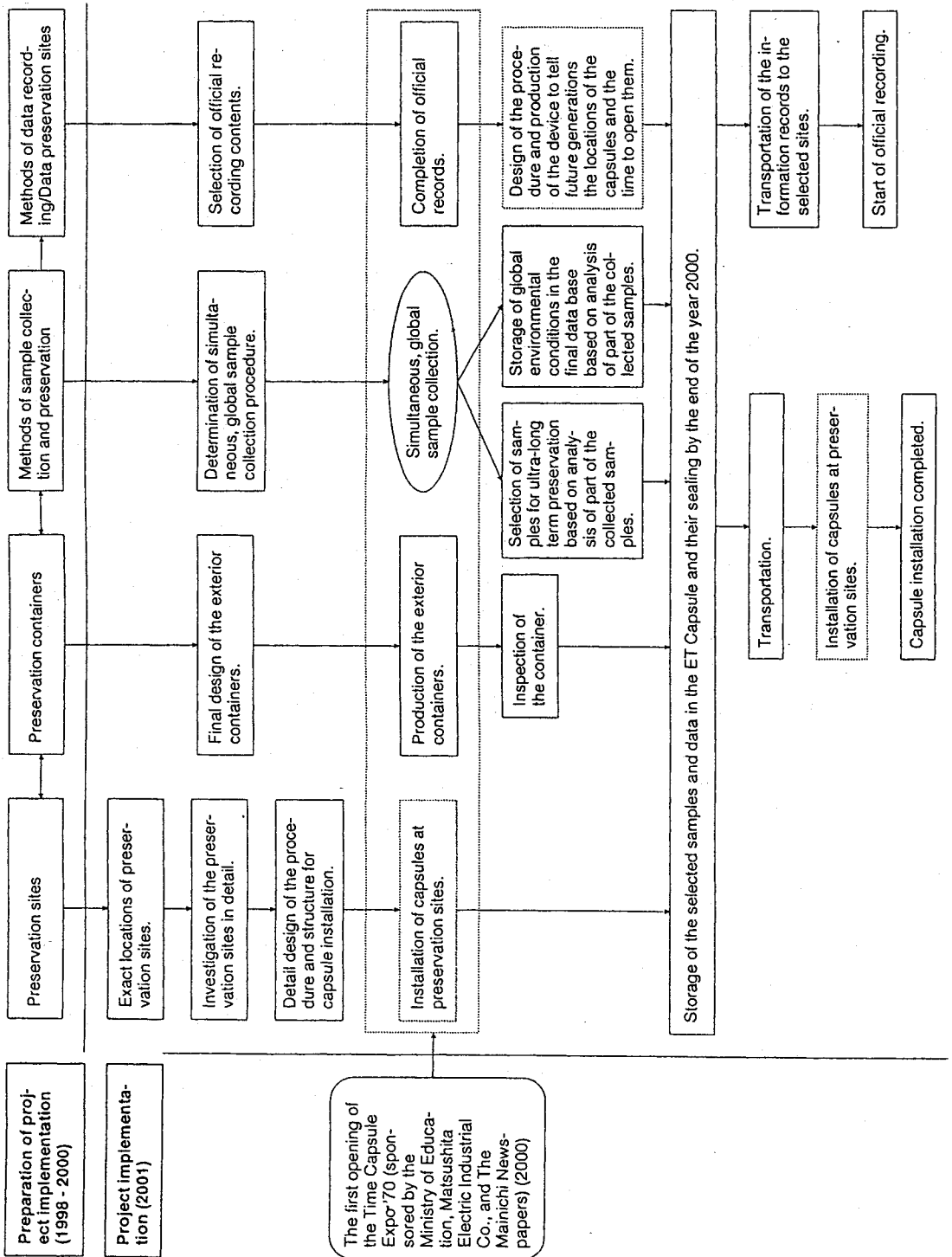


Figure 6. Project schedule 3