The “Quaternary Maps of Japan” Published in 1987, Compared with Other Quaternary Maps of World¹⁾

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The Japan Association for Quaternary Research published the “*Quaternary Maps of Japan*”, with an explanatory text, through the University of Tokyo Press, in 1987. This paper presents an outline of the publication together with a discussion of its contents, including the characteristics of Japanese Quaternary phenomena, and a comparison of the maps presented with various other Quaternary maps published by other organizations around the world.

I. The “*Quaternary Maps of Japan*” and its explanatory text

The publication of the “*Quaternary Maps of Japan*” was chosen, in 1985, by the Council of the Japan Association for Quaternary Research to be the 30th anniversary publication of the Association, which was established in 1956. An editorial committee was organized, including the following individuals and their specialties :

Base maps and general map complication

S. KAIZUKA and N. YONEKURA

Quaternary strata

M. ITHARA

Volcanoes, tephra and large scale landslides

H. MACHIDA

Marine and fluvial terraces and lowlands

Y. OTA and N. YONEKURA

Submarine features and marine environment

Y. IWABUCHI and K. CHINZEI

Tectonics

T. KAKIMI and T. MATSUDA

Glacial landforms and low-relief erosion surfaces

T. KOAZE

Periglacial phenomena

S. IWATA

Soils

Y. KATO and S. NAGATSUKA

Plant fossils

K. SOHMA

Animal fossils

T. KAMEI

Archaeology

H. HARUNARI

Artificial landforms

K. KOIKE

The choice of these fields reflects the nature of the Japanese Quaternary and the state of Japanese Quaternary studies. Source data for the maps were piled through the collaboration of

about 120 individuals from various fields and numerous institutions, including the Geological Survey of Japan, the Geographical Survey Institute, and the Hydrographic Department. These data were first compiled for each field, and then combined into two different types of sheet map, with different scales : I. Landforms, Geology and Tectonics (1 : 1,000,000) in 3 sheets — A. Northeast Japan, B. Central Japan, and C. Southwest Japan; and II. Prehistoric Remains and Paleogeography (1 : 4,000,000) in one sheet containing four paleogeographical maps of Japan.

The maps were printed in eight colors, as shown in the partial examples (Plates 1~4 of the front color pages), and published in 1987 with one volume of explanatory text of 119 pages (in Japanese), by the University of Tokyo Press (Hongo, Bunkyo-ku, Tokyo ; with a price of ¥12,000).

II. Main features shown in sheet map I. Landforms, Geology and Tectonics

A portion of map IB (Central Japan), of around Tokyo, is reproduced (Plate 2) at the 80% scale of the original and the legend from sheet map I is shown in Plate 3, at a scale reduced from the original. As seen in the legend, volcanic and non-volcanic landforms and strata are classified according to their facies (arranged horizontally) and by their geological ages (arranged vertically).

The geological age sub-divisions of the

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2) [REDACTED]

Quaternary are the Holocene (H), Late Pleistocene (L), Middle Pleistocene (M), and Early Pleistocene (E). The Late Pleistocene is further subdivided into the Last Glacial and the Last Interglacial, using the symbols "L II" and "L I" respectively to mark fossil sites for land animals, and "L' " and "L" respectively for marine or fluvial landforms and strata. Radiometric ages for these divisions and subdivisions are indicated on both sides of the columns, in increments of 10 ka from younger to older as follows : 1=the beginning of the Holocene, 6=the beginning of the Last Glacial, 13=that of the Last Interglacial, 70=the Brunhes—Matuyama boundary, and 170=the Olduvai event.

The ages of pyroclastic flows, craters, and marker tephra are indicated as Holocene or Pleistocene by color or symbol, and their radiometric ages are given with the abbreviated name of the tephra. For example, as in Plate 2, the notation Hk-TP (49 ka) refers to the marker tephra known as the Tokyo Pumice, derived from Hakone volcano, about 49 ka. Glacial and periglacial features, three kinds of soil, and Quaternary tectonic features are also shown, as well as submarine landforms and the bottom quality.

In the category of non-volcanic landforms and strata, marine landforms and strata (Lm) of the Last Interglacial are highlighted in yellow, because the marine terrace surfaces, either depositional or erosional, show evidence of the Last Interglacial marine transgression, which is an important historical and geographical reference marker for the Late Quaternary.

Interglacial and postglacial shorelines are shown in red lines with their elevation (a.s.l.) given in meters. The differences in elevations of synchronous shorelines result from local or regional crustal movements since their exposure. The highest Last Interglacial (S) shoreline (ca. 120 ka) and the highest middle Holocene (H) shoreline (ca. 7~5 ka) are about 200 m and 30 m above sea-level respectively.

These elevated shorelines and widely distributed marine terraces, that extend along the Japanese coast, clearly indicate that tectonic uplift is great across wide areas. The

distribution of Quaternary faults and folds also indicates that tectonic activity is strong in Japan, especially in the central part of Honshu. Submarine faults and folds are not shown on these map sheets, but are indicated on similar 1 : 1,000,000 scale maps in "*Active Faults in Japan : sheet maps and inventories*, revised edition," published in 1991 by the Research Group for Active Faults of Japan through the University of Tokyo Press.

Quaternary tectonic movements have made the Japanese Islands very rugged. Considerable amounts of debris have been supplied from growing mountains, and intermontaine basins and coastal embayments have been buried with fluvial and marine deposits. Therefore, the area consisting of non-volcanic Quaternary deposits is as wide as about 20% of the total land area of Japan. The land area of Quaternary volcanic rock, excepting tephra covered areas, is about 10%. Japan has no distinctive loess layers, but there are numerous tephra layers found in Quaternary marine and fluvial deposits, and on land surfaces, as air-fallen loamy, sandy, or lappili layers.

Marker tephra, or widely distributed identifiable tephra layers, are very important to the Japanese Quaternary chronology. The distributions of some are shown in Plates 1, 2 and 4. Through research with marker tephra, Japanese Quaternary studies have progressed far in fields such as : general stratigraphy, terrace studies—connected with climatic and sea-level changes, tectonic studies—concerned with absolute rates of movement, glacial, periglacial, and pollen analytical studies associated with radiometric ages, studies of slope developments in temporal sequence, changes in marine environments studied from submarine cores which include marker tephra, paleosol studies and so on.

No glaciers exist in Japan today, but many (mostly cirque glaciers) existed on the higher mountains in central Honshu (see Plate 1) and in Hokkaido. Periglacial frost/thaw phenomena are seen at high elevations and in northern Japan today, while periglacial phenomena including those of permafrost formed during the Last Glacial are widely recognized in central and

northern Japan (Plates 1 and 2). It is known, however, that periglacial phenomena were prevented by accumulation of snow along the Japan Sea side area of northern Japan (see Plate 1).

Detailed drawings of submarine channels on coastal shelves (brown lines), which are mostly buried by recent deposits, are shown on sheet map I. Buried valleys beneath Holocene alluvial plains (green dashed lines) and submarine channels were river valleys in times of lower sea-levels; most of them being formed in land environments during the Last Glacial low sea-level. These features are found by seismic soundings or from borehole data. The edge of the coastal shelf and its depth are also shown on the maps (Plate 2). The depth of the shelf edge is usually between -120 and -170 m, and the width of the shelf is generally narrow as compared to other continental shelves of the world.

III. Major features shown on sheet map II : Prehistoric remains and paleogeography

Sheet map II consists of four paleogeographic maps of the Japanese Islands (1 : 4,000,000 scale) : A. Last Interglacial Age (ca. 130~60 ka), B. Last Glacial Age (ca. 60~10 ka), C. Jomon Age (ca. 10~2.5 ka), and D. Yayoi, Kofun and Historical Ages (since ca. 2.5 ka). The main function of these maps is to locate sites with prehistoric remains and to indicate their natural environments. For this purpose it would be desirable, if enough data were available, to produce paleogeographic maps at intervals of ca. 10 ka for the Late Pleistocene, and of 1 ka for the Holocene. However, we do not have enough data yet, thus, the above four temporal categories were chosen, and the contents of the maps are not directly comparable.

In map A, Last Interglacial Age (ca. 130~60 ka), the shorelines represent those of ca. 120 ka, that is the stage of highest sea-level in the Last Interglacial (Eem, Sangamon, and Shimosueyoshi of Japan). Forest types shown in this map are located based on data from plant macro-fossils and pollen from about 120 ka, but animal fossil sites and marker tephra are

indicated for the whole range of this interval, i.e., ca. 130~60 ka. The sites with paleolithic remains are all older than ca. 30 ka, which is before the appearance of blade tool techniques in Japan.

In map B, a portion of which is shown in Plate 1—with its legend, phenomena from the Last Glacial are presented. Among them, shorelines, rivers, forest types, and glaciers all date to around 20 ka, which is the coldest climate and lowest sea-level phase of the Last Glacial. Paleolithic remains date between ca. 30~14 ka, which means that they coincide with the period of blade tool production. Marker tephra, pyroclastic flows, and animal fossil sites all date ca. 60~10 ka. The present depth of the ca. 20 ka shoreline should differ from place to place due to tectonic movements since that time. However, the exact depth is known at only a few locations; therefore, for this map, the -100 m bathymetric line is used tentatively. In other map (KAIZUKA and NARUSE, 1977) a line between -120 and -140 m was used to indicate the shoreline of the lowest sea-level phase of the Last Glacial.

In map C, shorelines at around 6 ka are shown, that represent the highest sea-level traces known for many areas of Japan. For the Middle Jomon Period (ca. 4~3 ka) the density of prehistoric sites is plotted in a grid (approximately 4×5 km) covering all of Japan, using three categories : 1~2, 3~4, and 5 or more sites per unit (Plate 4). The Jomon Period, the Neolithic age of Japan, characterized by Jomon (straw-rope patterned) earthenwares, is divided into five stages : the Earliest, Early, Middle, Late and Latest. It is known that the density of sites was not the same for each period, but this map (Plate 4) is the first illustration of the density pattern of sites for the whole of Japan in the Jomon Period. As seen in this map, the higher site density areas are found in central Honshu, especially around the Tokyo Bay area, and in northeast Japan, including Hokkaido.

In map D, remains of Yayoi Period (4th century B.C. ~ 3rd century A.D.) rice fields, major tomb mounds of the Kofun Period (3rd ~ 6th century A.D.), sites with animal bones and marker tephra dating since ca. 2.5 ka, are shown, as well as

present day landform divisions and the distribution of coral reefs in the Ryukyu Islands. Coral reefs were distributed throughout the Ryukyu Islands during the Last Interglacial Age (map A) and the Holocene (maps C and D), but for the Last Glacial Age (map B) coral growth is not known.

IV. Concluding Remarks—Characteristics of the “*Quaternary Maps of Japan*”

The “*Quaternary Maps of Japan*”, needless to say, reflect Japan’s natural characteristics, their changes during the Quaternary, and also human activity. Some of the changes were directionally successive, like crustal movements, and others alternating, like climate and sea-level changes.

The Japanese Islands have changed their landforms and coastlines through powerful and complex tectonic movements, vigorous volcanic eruptions, sea-level changes, and also by strong fluvial and marine erosion and sedimentation during the Quaternary. Therefore, sheet map I. Landforms, Geology and Tectonics shows more complicated land features for the Quaternary than do maps of Europe (BUNDESANSALT FÜR BODENFORSCHUNG, 1967~), the USSR (МИНИСТЕРСТВО ГЕОЛОГИИ СССР, 1973), and the central-eastern United States (U.S. GEOLOGICAL SURVEY, 1986). Sheet map I is similar to the Quaternary Geological Map of New Zealand (NEW ZEALAND GEOLOGICAL SURVEY, 1973) in land features and their complexity, which provided a good example to follow when making our Quaternary maps.

The Japanese Islands had no extensive ice cover during the Pleistocene cold ages, therefore, Japan has no distinct features from retreating ice margins in the latest Pleistocene and Holocene, compared with mountains covered by ice caps such as South Island of New Zealand (NEW ZEALAND GEOLOGICAL SURVEY, 1973) and other mountains in higher latitudes, and areas covered by ice sheets such as in Canada (GEOLOGICAL SURVEY OF CANADA, 1987a) and Scandinavia (GEOLOGICAL SURVEY OF SWEDEN, 1958). Japanese coasts thus exhibit no glacial isostatic uplift and accompanying shoreline change, as seen in Canada (GEOLOGICAL SURVEY OF CANADA, 1987b) and

Scandinavia (GEOLOGICAL SURVEY OF SWEDEN, 1961), but show a fair amount of tectonic uplift, as much as 30 meters since the Middle Holocene.

Due to the lack of ice cover and presence of extensive tephra cover the Japanese Islands have various records of the Pleistocene, such as changes in shoreline, sea-level, tectonic landforms, and sediments, as well as changes in vegetation, animals, soils and paleolithic human remains. It may be said, however, that the area of exposed early and middle Pleistocene deposits is not as extensive as that of the late Pleistocene and Holocene deposits. This is because the sedimentary zones of Japan are those that have subsided and then covered by younger deposits (Figure 2 shows an exceptionally large exposure of early and middle Pleistocene strata, and is recognized as an important type area of the Japanese Quaternary). This is a different situation than found in the marginal area of continental ice sheets, such as in central Europe (INSTYTUT GEOLOGICZNY, 1965) and the central United States (ILLINOIS STATE GEOLOGICAL SURVEY, 1979).

Quaternary submarine features around the Japanese Islands are also rich in evidence, such as shelf features with buried channels, tectonic landforms, a variety of submarine sediments—including coral deposits, tephra, and so on.

The “*Quaternary Maps of Japan*” present, as described briefly here, the known Japanese Quaternary features, as well as important results from Japanese Quaternary research carried out during the last century, especially in the last 30 years, since the establishment of the Japan Association for Quaternary Research.

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凡例 Legend

火山の地形と噴出物 Volcanic landforms & products

非火山の地形と地層 Non-volcanic landforms & strata

地質時代 Geological age

氷河・周氷河現象 Glacier & periglacial phenomena

土壌 Soils

テクトニクス Tectonics

海底地形と底質 Submarine landforms & bottom quality

Plate 3 Legend for the "Quaternary Maps of Japan" I

Plate 4 Part of the "Quaternary Maps of Japan", II. Prehistoric Remains and Paleogeography, C. Jomon Age