ABSOLUTE AGE OF SUBSURFACE LATE QUATERNARY DEPOSITS IN THE NIIGATA LOWLAND

by

M. MINATO, K. SUYAMA, K. HASEGAWA, A. OYA, Y. TAKAHASHI, K. NAKAGAWA, N. WADA, and T. SHIBAZAKI

(with 4 Text-figures)

(Contribution from the Department of Geology and Mineralogy, Faculty of Science, Hokkaido University. No. 1058)

Through drillings and seismic investigations for oil and gas, the subsurface geology in the area surrounding the so called Niigata lowland, facing the Japan sea in central Honshu, had been clarified to some extent prior to our recent investigation. The top of the Neogene, for instance, had been traced widely in this area at a depth of several hundred meters below the sea level. The Neogene is unconformably overlain by Quaternary deposits which completely bury a flat maritime plain. Furthermore, the existence of extensively developed gravel beds within the Quaternary deposits were also detected by oil geologists at several horizons and have been called gravel beds 0, 1, 2, 3, 4 and 5 ($=G_0$, G_1, G_2, G_3, G_4 and G_5) in descending order. The base of the bed G_1 has been believed to unconformably overlie the underlying formation, and the existence of another unconformity was also proved at a horizon slightly below gravel bed_5: this surface can be designated as the boundary between the Tertiary and Pleistocene in this area, although its correlation is tentative because of the lack of fossils or other suitable materials for reliable age dating.

The authors' investigations in the Niigata region over the past several years were concentrated principally on the Late Quaternary deposits. Although two rather deep drillings made in the central part of this area reached as deep as 770 and 950 m respectively and deeply penetrated the Neogene, most of bore holes made were much shallower. For example, of drillings at 37 especially selected localities only 7 bore holes reached gravel bed_1. The mean depth of these drillings was less than 56 m from the surface. In addition, very shallow drillings were made by hand auger at about 110 points, as well as Swedish sounding operated at 512 points. The purpose of these was to obtain detailed informations concerning the very shallow subsurface geology.

As a result, the Late Quaternary deposits overlying gravel bed_1 in this area are now divisible into two major groups, which the authors propose to call the

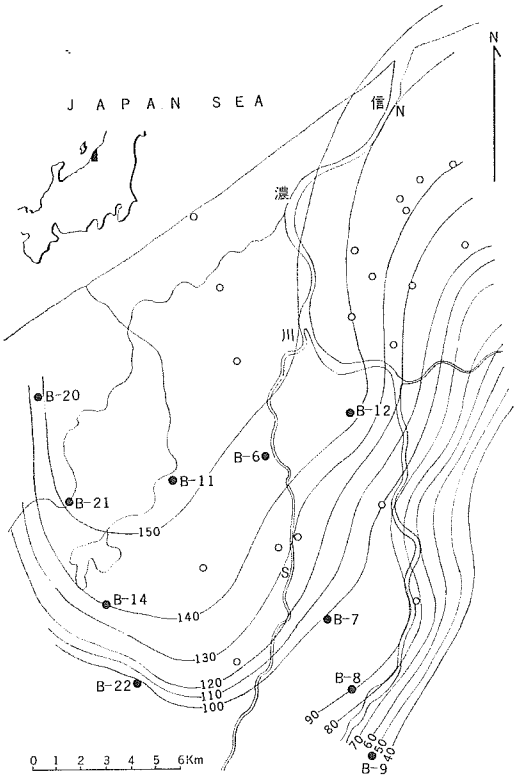

Fig. 1
Structural contour map of the base of the Nishikanbara Group in the Niigata lowland. Circles indicate localities where new drilling were made except for very deep and shallow ones. Black circles indicate drillings whose geological sections are shown in the diagramatic profile (fig. 2). N: Niigata City.

Nishikanbara Group and Shirone Group in ascending order.

Gravel bed$_1$, which unconformably overlies the underlying strata, would seem to form the basal complex of the Nishikanbara Group. However, it actually is distributed only over the buried flat plain, the depth of which ranges from 130 to 150 m below sea level. This gravel bed$_1$ likely consists of buried terrace gravels. It is, in fact, not traceable to the east into an area represented by a gentle westward slope which is less than 120 m in depth. In this area, the Nishikanbara formation is considered to overlap the strata older than the gravel bed$_1$ (Fig. 2).

The Nishikanbara Group is chiefly composed of thin-bedded alternating silts and fine-grained sands with locally intercalated peat layers. It is considered to have been deposited in a lacustrine or lagoonal basin on the basis of its lithology

and fossils. The age of this deposit has now established to range from about 26000 to 25000 y.B.P. (26200±1000 to 24800±1000 y.B.P.) by radiocarbon dating of pieces of wood encountered between 82.6 and 91.3 m below sea level (drilling site B_7). And also from samples recovered from a depth of about 146 m below sea level (drilling site B_{11}) (see figs. 1 and 2)

There is an remarkable unconformity between the Nishikanbara Group and the overlying Shirone Group, inasmuch as certain layers (or member) of the former are lacking at this boundary and a marked difference in age is proved by Carbon age determinations.

The Shirone Group is lithologically divisible into three units. The lowermost of these is chiefly composed of alternating sands and silts similar to the lithology of the Nishikanbara Group. The middle unit is mainly composed of clays. The upper unit consists of several lithofacies but can be regarded as mainly consisting of sands, gravels and peats. As concerns the ecological condition represented by these deposits, a major cycle from limnish-brackish to marine and a return to brackish-limnish can be postulated, but these deposits seem to have accumulated in an restricted bay, as a whole.

The base of the Shirone Group can now be established to lie at depths rang-

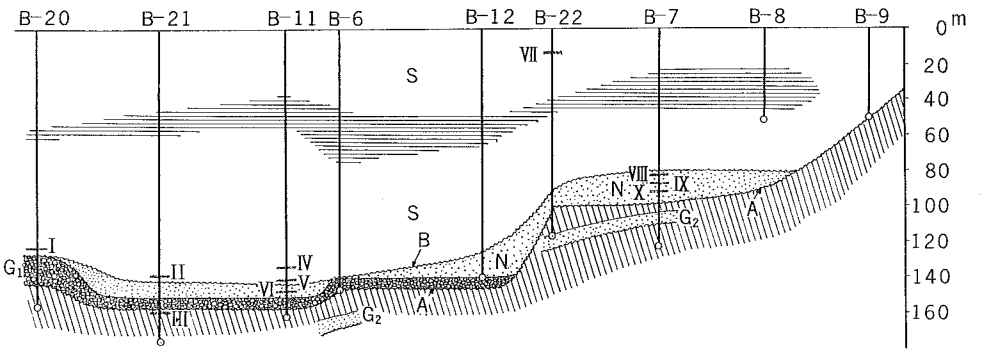

Fig. 2

Profile of the units younger than gravel bed_2 in the Niigata lowland. Bore holes localities are shown in the fig. 1. Inclined hatched lines indicate stratigraphic units older than gravel bed_1. G_2: Gravel bed_2; G_1: Gravel bed_1; N: Nishikanbara Group; S: Shirone Group; A: unconformity at the base of gravel bed_1 and the surface transgressively overlapped by the Nishikanbara and Shrione Groups. Horizontal lines indicate the clay facies which predominates in the middle division of the Shirone Group. I, II, III, . . . X indicate horizons where the samples for age determination were obtained from each drilling.

I: 123.50 m (18300±500 y.BP) II: 139.50 m (20900±600 y.BP) III: 159.50 m (over 31000 y.BP) IV: 134.0 m (10900±250 y.BP) V: 141.0 m (20300±600 y.BP) VI: 146.0 m (25500±1100 y.BP) VII: 13.8 m (41150±120 y.BP) VIII: 82.66 m (24800±1000 y.BP) IX: 87.66 m (23000±1000 y.BP) X: 91.36 m (26200±1000 y.BP) Among which, the age of sample IV and IX can not be well explained.

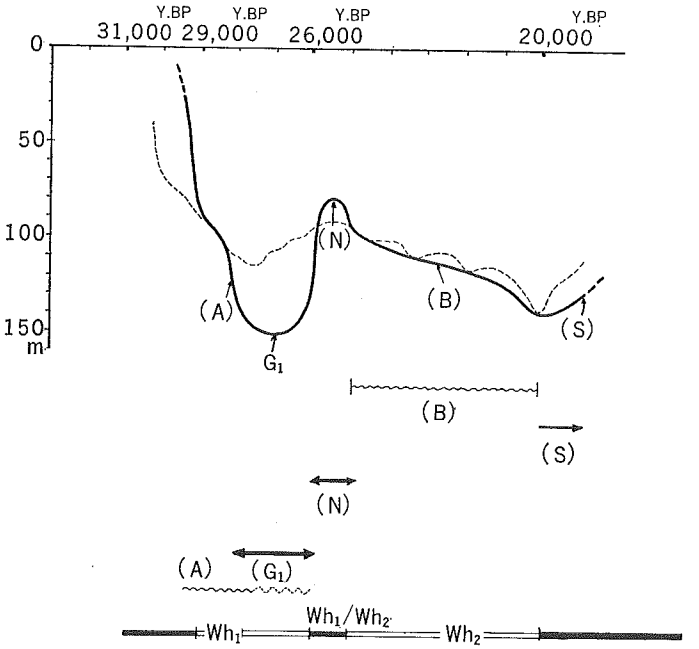

Fig. 3.
Sea-level changes represented by strata younger than the gravel bed_2 in the Niigata lowlands. Thick downward curve indicates intervals of erosion; upward curves, of gravel bed_1 (G_1); Dashed line representes the changes of sea-level formerly postulated by MINATO (1966) from other sources.

(A) Age of the erosion followed by the deposition of gravel bed (G_1)
(N) Age of deposition of the Nishikanbara group.
(B) Age of erosion indicated by the unconformity at the base of the Shirone group.
(S) Age of the deposition of the Shirone group.

ing from 140 m to less than 50 m, as is shown in figs. 1 and 2, this may suggest to us that this group overlapped the uneven surface of the Nishikanbara Group and pre-Nishikanbara strata. This surface may have been resulted from erosion prior to the transgression represented by the Shirone Group. The deepest deposits of this group overlie a rather flat plain at about 140 m below the sea-level. The age of these basal deposits is now dated at nearly 20000 y.B.P. (20300±600 to 20900±600 y.B.P.) (Fig. 2). Accordingly, the duration of the hiatus represented by the unconformity found between the Shirone and Nishikanbara Groups can be estimated at about 5000 years, inasmuch as the upper part of the Nishikanbara Group has been dated at 25000 y.B.P.

The absolute age of the Shirone Group at several horizons was obtained from samples recovered from a depth about 123.5 m below the sea-level at drilling site

B_{20} and from a depth of 13.8 m at drilling site B_{22}. These dates are about 18300± 500 and 4100±120 y.B.P. respectively.

The age of the gravel bed_1 is not definitely known, but it is certainly younger than 31000 y.B.P., since the age of samples collected from site B_{21} at a horizon about 5 m below this gravel bed_1 has been dated at over 31000 y.B.P. In all probability, the unconformity at the base of gravel bed_1, as well as elsewhere at the base of the Nishikanbara Group may represent a period of erosion that occured during a time of sea-level lowering. The gravels of bed_1 may have been deposited when this lowering lingering at a level between 130 to 150 m below the present sea-level, between 31000 and 26000 y.B.P. This interval thus can be correlated to the Wh_1 (Hauptwürm 1).

The subsequent deposition of the Nishikanbara Group represents the age when the sea-level rose from 150 m to 80 m below the present sea-level. It is worth noting that the top of these strata occur at a depth of about 80 m below the present sea level, indicating that the Nishikanbara Group can be now regarded as have been deposited during the inter-ice age. This interval is correlatable to the Wh 1/Wh 2, since the absolute age of the Nishikanbara Group ranges from about 26000 to 25000 y.B.P.

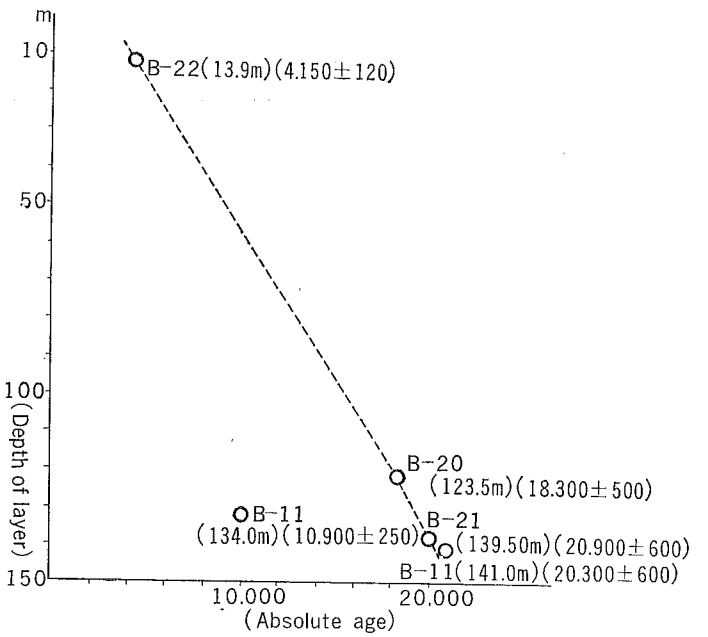

Fig. 4
Absolute age of the Shirone Group determined by samples collected from various depths.

As is stated above, the unconformity at the base of the Shirone Group can be regarded as evidence for the next lowering of the sea-level. It ranges in age from 25000 to 20000 y.B.P. The lowering of this phase began from a depth at about 80 m below the present sea-level and finally reached a level of about 140 m. The age of this lowering corresponds to the early half of the Maximum Würm, Wh 2.

After this final major lowering, sea-level again became gradually higher as the Shirone Group was deposited. Episodic minor sea-level lowering may have occured many times since 20000 y.B.P., but because of limited data this history cannot be stated in detail. However, several minor unconformities and diastems below units composed of dune sand or gravels (e.g., Gravel bed_0) are known to occur in the Shirone Group.

In conclusion, the strata younger than gravel bed_1 in the Niigata lowland form a complicated stratigraphical succession that includes many stratigraphical hiatus produced by the effects of sea-level changes during the Late Pleistonce and Holocene.

At this ocassion, we should like to express our thanks for Prof. K. KIGOSHI, Gakushuin Univ. in Tokyo, for his kindness in age determination of the samples reported in this paper.

Reference

MINATO, M. (1966): The final stage of Land bridges in the Japanese islands, Earth Science, nos. 85–86, pp. 2–11.

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