The Correlation of Plio-Pleistocene Strata in Japan Based on Volcanic Ash Keybeds

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The Correlation of Plio-Pleistocene Strata in Japan Based on Volcanic Ash Keybeds

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Abstract - Volcanic ash keybed is a most precise indicator of contemporaneous datum planes of geological age. Recently, several Pliocene to Early Pleistocene wide spread volcanic ashes were reported from central Japan. Volcanic ash keybeds contribute chronologically to the study of paleoclimatic changes and tectonic events. While most of the correlations of the Pliocene-Pleistocene strata by volcanic ash keybeds are consistent with the correlations based on biostratigraphy, several of them are not consistent between the biostratigraphic bases and volcanic ash bases.

I. Introduction

Volcanic ash beds are most precise contemporaneous datum planes of geological age. Many volcanic ash beds are intercalated in the Pliocene to Pleistocene strata in Japan. Volcanic ash beds are reported to be the useful marker bed for the chronology of the Quaternary climatic or tectonic events in or around Japan. For example, middle to late Pleistocene glacial-interglacial records were correlated between the Boso Peninsula and the Oiso hill [1]. High-resolution sequence stratigraphy of submarine fan system was reported using volcanic ash keybeds at the Kazusa Group [2]. Glacial eustatic sea level changes during the Pliocene to Early Pleistocene were reported to have 41k years periodicities, which were short compared with the Middle Pleistocene to Holocene sea level changes [3]. These facts indicate that chronological study of the Pliocene-Pleistocene sea level changes needs more precise datum planes. In the Middle Pleistocene to Holocene, many wide spread volcanic ashes have been reported by previous works. The Pliocene to early Pleistocene wide spread volcanic ashes were recently started to report by several studies [4,5]. For example, the Hotaka-Kd38 and the Ebisutoge-Fukuda Tephras were reported that were widely distributed in the central Japan [5]. Some of those volcanic ash keybeds were even traced to other distant regions [6].

The Pliocene to Pleistocene strata are widely distributed from the northeastern to the central Japan. The Pliocene-Pleistocene marine or non-marine strata in Japan were correlated with each other based on the biostratigraphy, magnetostratigraphy, tephrostratigraphy, and the radiometric age. Calcareous nannofossil biostratigraphy provides global and the most useful datum plane for stratigraphical age in marine sediments. However, calcareous nannofossil biostratigraphy is not enough precise to evaluate the correlation of the record of periodic glacial eustatic sea-level changes [7], and impossible to date non-marine strata. Volcanic ash keybeds are possible to dating of non-marine strata with the help of palaeoclimate records. The author introduces examples of the contribution of volcanic ash keybeds to paleoclimatic study, and compare the correlation of the volcanic ash keybeds with biostratigraphy and/or radiometric age.

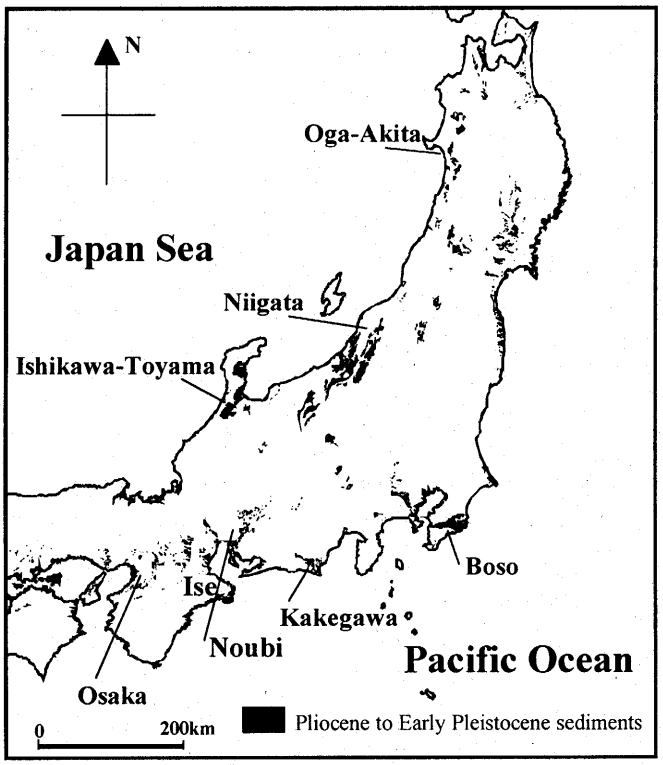

Fig. 1. The distribution of the Pliocene to the Early Pleistocene strata in the northeast-central Japan.

II. Correlation of Strata the Pacific Ocean Coastal Areas

Localities of the representative of Pliocene-Pleistocene sequences of the Pacific coast in Japan are the Boso peninsula, the Kakegawa district, the Ise-Noubi Plain and the Osaka Plain. These localities have the strata that are called the Kazusa, the Kakegawa, the Tokai and the Osaka Groups, respectively. Many tephrostratigraphic studies were reported from these Groups based on the petrographical characteristics. The Kazusa Group is comprised of marine facies. In the Kazusa group, high-resolution sequence stratigraphic studies recognize eighteen depositional sequences, and these sequences are correlated to the oxygen isotope stages from deep-sea cores based on

fission-track age of the volcanic ash bed, magnetostratigraphy and calcareous nannofossil biostratigraphy [2]. The Osaka Group is mainly comprised of non-marine facies, and is intercalated twenty marine clay beds and many volcanic ash beds. Twenty marine clay beds are called the Ma-1, Ma0, Ma0.5, Ma1, Ma2... and Ma12 from the bottom to the top. These marine clay beds were traced using the volcanic ash keybeds under the Osaka plain, and correlated to oxygen isotope stages based on volcanic ash keybeds and magnetostratigraphic study [8]. The volcanic ash keybeds correlate the records of sea-level changes between the Kazusa and the Osaka groups. At the Early Pleistocene, the Azuki Volcanic Ash keybed in the Osaka Group was correlated to the Ku6c pyroclastic keybed. The Correlation of the Azuki and Ku6c volcanic ash beds indicates that the correlation of depositional sequence 7 of the Kazusa Group [2] and the Marine clay bed Ma3 of the Osaka Group [8].

III. Correlation of Strata in the Japan Sea Coastal Areas

Localities of the representatives of the Japan Sea coastal Pliocene-Pleistocene sequence are the Oga Peninsula, the Niigata district and the Ishikawa-Toyama district. These localities have the strata called the Funakawa-Kitaura Formations, the Nishiyama-Haitsume Formations and the Himi Group, respectively. Tephrostratigraphic studies based on petrographical characteristics were reported from the Niigata and Ishikawa-Toyama districts. In the Niigata district, the representative of the Pliocene-Pleistocene strata are the Nishiyama Formation, the Haitsume Formation and the Uonuma Group. Sequence stratigraphic study was reported from the Uonuma Group, and the Group was correlated to oxygen isotope stages based on tephrostratigraphy and the age of volcanic ash beds at the Uonuma Group [24]. In the Himi Group, sedimentary cycles were reported from the Omma and the Junicho Formations [25, 26]. Sedimentary cycles of the Junicho Formation were dated and they turned out to include the Plio-Pleistocene boundary. Then, they were correlated to the sedimentary cycles of the Uonuma Group based on volcanic ash keybed named the Ebisutoge-Fukuda Tephra [14]. The calcareous nannofossil biostratigraphy was studied for the Ishikawa-Toyama district [27,28]. In several sections of these districts, the correlation in the Himi Group suggested by tephrostratigraphic study is different from the correlation in the Himi Group based on calcareous nannofossil biostratigraphy [13,15]. The Ishikawa-Toyama district is geographically close to the Osaka Plain where non-marine sediments were widely distributed. This district is expected to have volcanic keybeds that can be correlated to volcanic ash beds of the Osaka Plain.

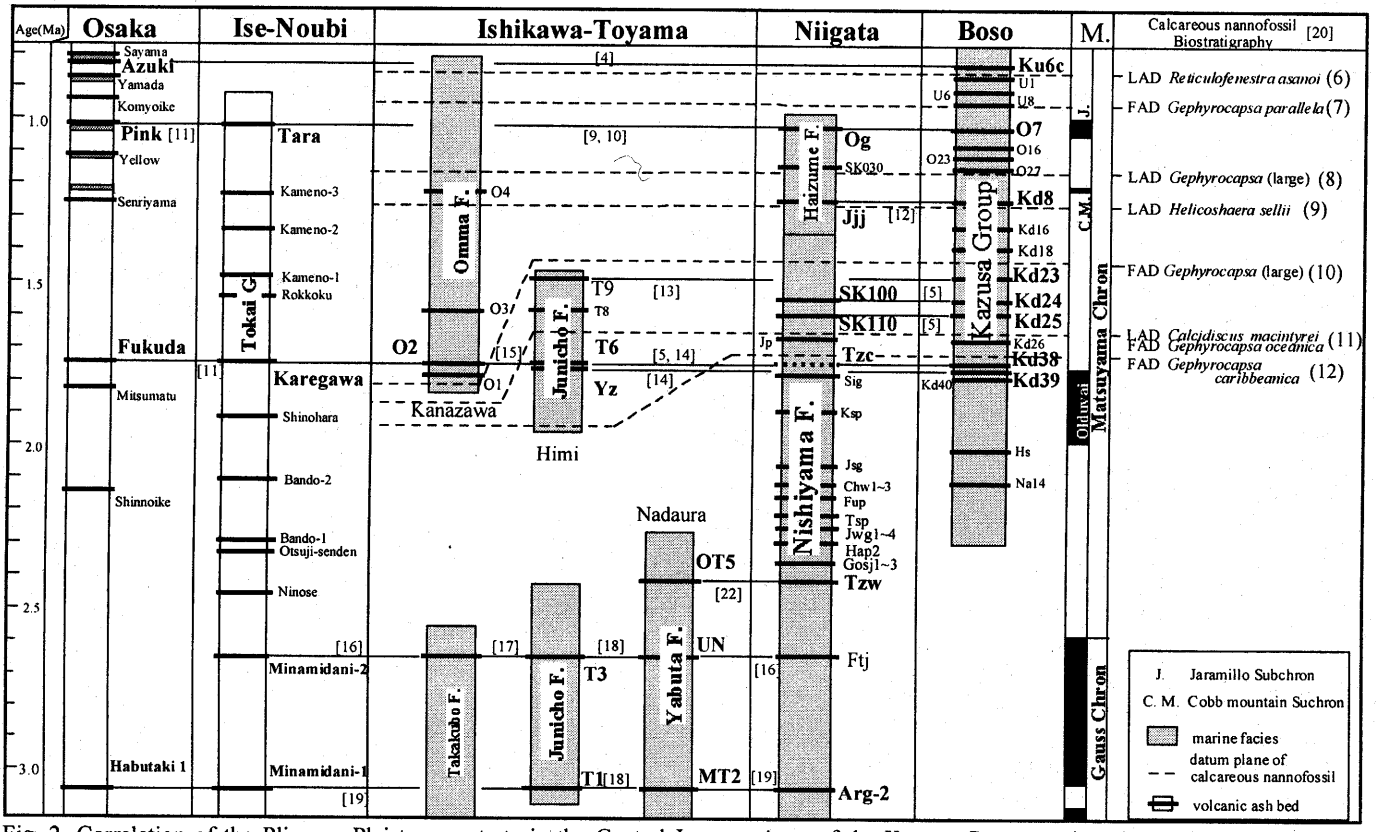

Fig. 2. Correlation of the Pliocene-Pleistocene strata in the Central Japan. Ages of the Kazusa Group are based on biostratigraphy [21], magnetostratigraphy [22] and radiometric age [23]. Ages of other strata are based on tephrostratigraphy and magnetostratigraphy.

VI. Summary

Volcanic ash keybeds are not used as global datum planes. These keybeds are, however, precise indicators for chronological study of paleoclimatic or tectonic events. Volcanic ash keybeds are especially important marker-beds for non-marine strata. These keybeds are possible to be cross-checked and directly correlate sea-level change records between non-marine and marine sediments. In several sections, the geological age estimated by calcareous nannofossil biostratigraphy was reported to be different from those based on tephrostratigraphy. Volcanic ash keybeds are expected to provide important contemporaneous datum planes in the Pliocene-Pleistocene strata for the study of paleoceanographic change at the Japan Sea and the Pacific Ocean coasts.

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