# Integrated Mega- and Micro- Biostratigraphy of the Campanian–Maastrichtian Izumi Group, Southwest Japan –Toward Chronostratigraphic Correlation with Non-marine Deposits in the Songliao Basin, Northeast China–

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# Abstract

The Cretaceous was a time of long-term climate stability with warm equable climates resulting from higher atmospheric greenhouse gas content by volcanic activity. However, it is insisted the global cooling had occurred during the Campanian–Maastrichtian by recent works. To discuss the relationship between biota and the global cooling in the future, we need to establish a precise chronostratigraphic framework during the Campanian–Maastrichtian.

The Izumi Group is the upper Cretaceous marine deposit distributed in southwest Japan. This group yields mollusk, radiolarian, and terrestrial-derived palynomorphs such as spores and pollen. Therefore, the Izumi Group is favorable to establish an integrated mega- and micro-biostratigraphy that is applicable to the Campanian–Maastrichtian pelagic and terrestrial deposits and/or enables to correlate between them. This study considers lateral extension of molluscan zone, compositional changes of radiolarian assemblage, and palynomorph biostratigraphic framework for establishment of the integrated biostratigraphy.

The Izumi Group is divided into three lithofacies: the Northern Marginal Facies (NMF), the Main Facies (MF), and the Southern Facies (SF). The NMF accumulated contemporaneously with the MF in different place within the basin. Most of the molluscan specimens and biozones have been recognized in the NMF. Meanwhile, radiolarian zones are established by specimens occurring mainly in the MF. Thus, molluscan biostratigraphy is applicable only to the NMF, whereas radiolarian one is available only to the MF. To integrate both biostratigraphies, chronozones based on the time spans of molluscan zones are proved to be effective on both facies. The *Pravitoceras sigmoidale* Zone within the NMF extends to the MF and thickens toward southwestern direction. In this case, the *P. sigmoidale* Chronozone also continues from the NMF to the MF. It is interpretable that chronozones based on other molluscan zones continue into both lithofacies as well as the *P. sigmoidale* Chronozone. In other words, these chronozones are applicable to the MF and/or radiolarian zones. Thus, molluscan biostratigraphy enable to integrate with radiolarian one

To apply the integrated biostratigraphy to pelagic deposits, we need to understand compositional changes of Cretaceous radiolarian assemblage toward lateral direction. This study examined it within the *P. sigmoidale* and/or *Stichomitra cechena* zones. Radiolarian assemblages

appear from the NMF (inshore deposits) and MF (offshore deposits). Some species appear from both lithofacies. In addition, discoidal Spumellarian radiolarians are dominated in the assemblages from the NMF, while they are scarce in the assemblages from the MF. Nassellarian radiolarians appear characteristically in the later lithofacies. These tendencies of compositional change help to correlate radiolarian assemblages between the Izumi Group and pelagic deposits. It is expected that Nassellarian radiolarians are main component, while discoidal Spumellarian species are scarce in pelagic assemblages.

Based on the first occurrences of marker genera and species of the genus *Aquilapollenites*, four palynomorph interval zones are defined in the Izumi Group (in ascending order): the *Polyvestibulopollenites–Tricolporopollenites* (*P–T*), *Betulaepollenites–Graminidites* (*B–G*), *Ulmipollenites–Toroisporis* (*U–T*), and *Aquilapollenites–Hymenophyllumsporites* (*A–H*) interval zones. The *B–G*/*U–T* zonal boundary is regarded as the same stratigraphic position of the *P. awajiensis*/*N. hetonaiense* boundary. In other words, the *B–G*/*U–T* zonal boundary approximates the C/M boundary within the Izumi Group.

The SK1 (N) that is one of the core samples obtained from centre of the Songliao Basin. Four palynomorph interval zones are re-established in the study section within the SK1 (N) (680.0–862.0 m depth) to correlate with palynomorph assemblages of the Izumi Group (in ascending order): the *Liliacidites–Jianghanpollis* (*L–J*), *Chenopodipollis–Aquilapollenites* (*C–A*), *Translucentipollis–Toroisporis* (*T–T*), and *Betulaceoipollenites–Tsugaepollenites* (*B–T*) interval zones. Judging from co-occurring genera and species, the *C–A*/*T–T* zonal boundary could coincide with the *B–G*/*U–T* zonal boundary within the Izumi Group. In this case, it is implied that the former boundary corresponds with the *Pachydiscus awajiensis*/*Nostoceras hetonaiense* and/or C/M boundaries. These results suggest that the C/M boundary within the SK1 (N) could be at 748.5 m depth according to palynomorph biostratigraphic correlation with the Izumi Group.