Fundamental problems of diatom assemblages for paleo-coastal environment reconstruction and tsunami deposit identification

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Diatoms are prolific fossils with siliceous frustules that are well-preserved in sediments. They have undergone extensive adaptive radiation in different aquatic environments; thus, in geology, diatoms are widely used as “facies fossils” to indicate past environments. The ecological information of modern species is used in the interpretation of fossil Holocene assemblages, and paleo-earthquakes and tsunami deposits, in coastal areas. However, information regarding their extant, in-situ conditions is not always preserved, and in many cases, there are differences between the living and fossil assemblages. For example, some species found in the living assemblage may be absent in the fossil assemblage, whereas others not found in the living assemblage may be prolific in the fossil assemblage. There are differences in the preservation/destruction rate of frustules between modern and fossil diatoms, which suggest that the process of fossilization or preservation after sedimentation (taphonomy) cannot be ignored during the reconstruction of paleo-environments using diatom assemblages.
Since the 2011 Tohoku Earthquake, on the Pacific coast, reports of fossil diatom assemblages found in tsunami deposits increased steadily, which indicated that the fossils were well-preserved immediately following deposition. Some common species have been identified in tsunami deposits listed in Northeast Pacific, Alaska, Japan, Kurile Islands, North Atlantic, North Sea, Chile, Indian Ocean, South Pacific, and New Zealand. However, the common features were not always recognized in the assemblage compositions.
In the Tokachi region of Hokkaido, Japan, for example, Mio-Preocene marine strata are distributed around the lowlands where 17th century tsunami deposits were also found, and reworked fossil marine diatoms from the marine strata were identified within the tsunami deposits and Holocene sediments. Hence, as these older fossil species create “noise” in the reconstruction of paleo-environments, diatom species contained in the surrounding marine strata should be listed and excluded from the analysis of Holocene sediments in such locations.
Problems in recognizing autochthonous/allochthonous species, and the retransportation and redeposition of fossil diatom species have been extensively discussed in taphonomy; however, the available knowledge is still insufficient. Therefore, it is important to identify the ecological details of diatoms in modern environments and the taphonomic processes influencing their assemblages. Furthermore, ensuring basic geology knowledge, including recognition of the strata distribution in the study area and the processes of landform formation, are important when using diatom assemblages. In this study, the key points for identifying sedimentary environments and the methods for solving the issues related to taphonomic processes of diatom assemblages are addressed.

Keywords: tsunami deposit, paleo-coastal environment reconstruction, diatom assemblage, taphonomy

