Variation of ichnodiversity and ichnodisparity in submarine channel-levee system: an example from the Oligocene Nichinan Group, southwest Japan

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This study presents an example of variation of ichnodiversity (the number of ichnotaxa) and ichnodisparity (the number of categories of architectural design in trace fossils) associated with changes in depositional environments within an ancient submarine channel-levee system. To understand the past variation in behaviors of benthic animals in response to paleoenvironmental conditions, it is required to assess trace fossil assemblages quantitatively from various aspects (e.g. abundance, bioturbation intensity, diversity, and disparity). Particularly, ichnodiversity which refers to variability in types of behavior of benthic animals has been used as a proxy of environmental stress and stability for interpretation of depositional facies. In addition, recent ichnological studies suggest that ichnodisparity, which represents variability of morphological plans in trace fossils, is an important characteristic of the trace fossil assemblages to assess cause of changes of ichnodiversity (e.g. Buatois et al., 2013). Ichnodisparity may reflect the number of body plans of the trace fossil producers, so that it allows more detailed interpretation for patterns of variation in ichnodiversity and composition of the trace fossil assemblages. However, very few attempts have been made to investigate variation in ichnodiversity together with ichnodisparity. The purpose of this study is to evaluate variation of ichnodiversity and ichnodisparity in field data obtained from the Oligocene Izaki Olistolith of the Nichinan Group, which is distributed in the southern part of Kyushu, southwest Japan. In this study, the classification scheme of architectural designs in trace fossils proposed by Buatois et al. (2017) is used.

The Izaki Olistolith is composed of the alternating beds of turbidite sandstone and mudstone, which can be divided into three stratigraphic units based on lithology: the lower, middle, and upper parts. The characteristics of depositional facies indicate that the deposits of the lower and upper parts are submarine levee deposits and that of the middle part is the submarine channel-fill deposit. As a result of the observation on the bottom surface of 95 turbidite sandstone beds, in total 22 ichnogenera were recognized in the Izaki Olistolith. These trace fossils are mainly composed of graphoglyptids, and are classified into 15 architectural designs. To correct the outcrop exposure bias on both of the number of ichnotaxa and architectural designs, following method was applied to the data: (1) the relationship between observed area and detected numbers of ichnotaxa and architectural designs is obtained by subsampling from outcrop images; (2) the coverage parameter that represents the completeness of fossil records is then estimated form the fitted curve of subsampled data; (3) the sample ichnodiverstiy and ichnodisparity calculated from a given value of the coverage parameter. As a result of this analysis, two types of variation patterns of the ichnodiversity were recognized. The ichnodiversity in the levee deposit is low while it infrequently spikes up at a few intervals. In the channel-fill deposit, the ichnodiversity increases upward associated with filling of the channel, and it gradually decreases upward in the uppermost part of the channel-fill deposit. With regard to trends in ichnodisparity, it varies correlated with the ichnodiversity in the levee deposits. In contrast, the ichnodisparity shows lower values than that of ichnodiversity in the channel-fill deposit, especially at the intervals that show relatively high ichnodiversity. These facts suggest that the trend in the ichnodiversity in the channel-fill deposit is higher than that in the levee deposit in contrast to the previous ichnofacies models. The differences in the

variation of ichnodiversity and ichnodisparity may be a key to understand ichnofacies of channel-levee system as well as the ichnospecies composition of trace fossil assemblages.

Keywords: trace fossil, ichnodiversity, ichnodisparity, submarine channel-levee system

