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Cretaceous benthic foraminifera in the north eastern Pacific

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The paleocenographic and paleoecological studies of benthic foraminifers during the Cretaceous have been discussed, particularly in relation with the Oceanic Anoxic Events (OAEs) that are recognized as extensively deposition of black shale in the Tethyan and Atlantic regions. However, the faunal turnover of benthic foraminifers in the North Pacific region has not been revealed except for the OAE 2 interval in the Cenomanian-Turonian boundary. In the present study, I revealed long-termed faunal turnover of benthic foraminifers from Hauterivian to Turonian in the eastern North Pacific regions, and discuss the cause of faunal change of benthic foraminifers during the Cretaceous.

The Budden Canyon Formation (BCF) is located in the eastern part of the North Pacific region and distributed in the Great Valley Sequence (GVS) in the northwestern part of the Sacramento Valley. This sequence consists of the Ogo, Roaring River, Chickabally, Huling Sandstone and Gas Point Members in ascending order, and ranges in age from the late Hauterivian to middle Turonian. This sequence is divided into three benthic foraminiferal zones of Trochammina tehamaensis, Recurvoides sp. A and Haplophragmoides obesus Zones that are characterized by several last occurrences of calcareous species and dominance of agglutinated species. Some 49 agglutinated species and 152 calcareous ones are identified.

Based on the Q-mode PCA and cluster analysis of benthic foraminifers, eleven clusters are recognized in the study sequence of the GVS. They are also summarized as four types from Type A to D. Type A is characterized by neritic to bathyal calcareous species with cosmopolitan ones such as Lenticulina and Laevidentalina, and is associated with agglutinated species of trochospiral forms (Trochammina) and elongate uniserial/multiserial ones (Gaudryina and Spiroplectammina). Types B to D are composed mainly of agglutinated species, but rare to absent of calcareous species. Type B is characterized by abundant elongate uniserial/multiserial forms (Gaudryna), as similar in Type A. Type C includes streptospiral (Recurvoides) and planispiral (Haplophragmoides) forms. The dominant groups of Type D are tubular (Bathysiphon). Recent morphological analysis of agglutinated species revealed that elongate forms is abundant in deep infauna and tubular, flat-shape and streptospiral globular forms represent shallow infauna and epifauna. The shallow infauna and epifauna of agglutinated species suggest eutrophic or oxygen-depleted environments, while deep infauna represent more oxic conditions of bottom water. Many Cretaceous study such as the Oceanic Anoxic Events (OAEs) also suggest that agglutinated faunas tend to be common in oxygen-depleted conditions and calcareous species is abundant in oxic conditions.

Based on these data, classification of clusters from Types A to D in the present study is interpreted by an adaptation of benthic foraminiferal assemblages in oxygen-deplete conditions on the bottom water. Benthic foraminiferal assemblages under remarkably oxygen-depleted conditions are dominated by Types C and D that is grouped as shallow infaunal and epifaunal forms of agglutinated species in morphology, while Type A including abundant calcareous faunas suggest oxygen-rich environments. Thus, my results imply that the benthic foraminiferal assemblages in the continental margin of North Pacific are strongly controlled by oxygenation level in the bottom water condition. The stratigraphic change of benthic foraminiferal assemblages in the GVS are explained by the fluctuation or expansion of the oxygen-depleted environments.