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## **Barremian-Turonian benthic foraminiferal assemblages from the Great Valley Sequence, California**

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The Budden Canyon Formation (BCF) is a thick sedimentary sequence comprising the Great Valley Sequence (GVS) in the northwestern part of the Sacramento Valley. The BCF consists mainly of mudstone, with intercalations of thick sandstone and conglomerate units. Based on macrofossil (i.e. ammonites and other mollusks), the age of the formation ranges from Hauterivian to Turonian. The studied sequence is located along the North Fork Cottonwood Creek (Shasta County) and is divided into the six units of the Ogo Member, Roaring River Member, Chickabally Member, Huling Sandstone, Bald Hills Member and Gas Point Member, in ascending order. The rocks contain abundant benthic foraminifers except for the Huling Sandstone.

A total of 201 morphotypes of benthic foraminifers (>125 µm), consisting of 49 agglutinated and 152 calcareous species, were identified in the studied section. Agglutinated species are dominant throughout the sequence. Calcareous forms generally comprise less than 30% of total specimens. The total abundance of benthic foraminifers decreases in the upper part of the Chickabally Member and the Bald Hills Member, while planktic foraminifers commonly occur in the Gas Point Member.

The benthic faunas were classified into three assemblages on the basis of species dominance. The Barremian Assemblages is characterized by dominance of *Trochammina tehamaensis* and common occurrence of *Marginulinopsis striatocostata* and *Astacolus pachynota*. The Aptian-Albian Assemblage is dominated by *Recurvoides* spp., with *M. collinsi* and *Uvigerinammina pacifica* common in the Aptian, and *Osangularia schloenbachi* and *Plectorecurvoides alternans* common in the Albian. The Cenomanian Assemblages are dominated by *Haplophragmoides obesus*, *Bulbobaculites fragmentarius* and *Gyroidinoides infracretaceus* in the early Cenomanian, while *Pleurostomella reussi* and *Quadrimorphina allomorphinoides* commonly occur in the late Cenomanian to Turonian.

The results of the calcareous nannofossil biostratigraphy and carbon isotope analysis of wood fragments were used in the recognition of several intervals of Oceanic Anoxic Events (OAEs) in the studied sequence. The Early Albian samples within Zone NC8A contain high total organic carbon (TOC) (2.5 wt.%), high abundance of radiolarians and dominance of *Haplophragmoides* spp. and *Bathysiphon* spp. Based on these observations, we correlate this interval to the OAE1b. A positive shift of ~5‰ in  $^{13}\text{C}_{\text{wood}}$ , along with high TOC values (1.2 to 1.8 wt.%) were recognized near the Cenomanian/Turonian boundary, within Zone NC 12. Zone NC12 is characterized by the dominance of *Valvulineria loetterlei* and *Hoeglundina chapmani*, and by the high abundance of radiolarians in the upper part of the interval. These results suggest that this horizon corresponds to the OAE2. Both OAE 1b and OAE2 are characterized by distinct extinctions of benthic species (OAE1b: 24.7%, OAE2: 27.3%).

OAE1c and OAE1d occur within Zones NC9A (early late Albian) and NC10A (late Albian), respectively. The samples corresponding to the OAE1c contain abundant *Bathysiphon* spp. and are barren of nannofossils. Similar to OAE2, radiolarians are abundant above the interval. However, TOC and  $\delta^{13}\text{C}_{\text{wood}}$  values do not show any significant change or excursion. The OAE1d interval is marked by an increase of 0.6 wt.% in TOC and 2‰ of  $\delta^{13}\text{C}_{\text{wood}}$  values, respectively. The samples in this interval are either barren of benthic fauna or only contain *Bathysiphon* spp. These two OAEs show low rates of extinction (OAE1c: 2.3%, OAE1d: 6.4%).

These faunal turnovers and radiolarian abundance trends observed in the OAEs of the Northern California are very similar to those observed in the Yezo Group of Hokkaido, Japan. Based on these two areas, we suggest that increased organic carbon burial during OAEs resulted in impoverished benthic faunas around the North Pacific continental margin.