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Cretaceous methane seeps and their fauna: Distribution, evolutionary patterns, and paleoecologic implications

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Methane seeps are sites where fluids rich in hydrocarbons and hydrogen sulfide leak onto the sea floor and support specialized animal communities dominated by taxa having symbiotic relationships with chemotrophic bacteria. These animals include vestimentiferan tube worms, several groups of bivalves, and brachiopods. Because the bacterial oxidation of methane facilitates the precipitation of carbonate, such sites and their fauna are often preserved in the fossil record.

In the Cretaceous methane seeps are known from Europe, central Asia, the Arctic, California, the Western Interior Seaway, and Japan. Many early Cretaceous sites are dominated by the brachiopod *Peregrinella*, which seems to have had a world-wide distribution. Other characteristic taxa are certain lucinid and modiomorphid bivalves and high-spired gastropods, which apparently had their origin in the latest Jurassic and were also widespread. The earliest methane seeps in which modern-day taxa like thyasirids and vesicomyids dominate are known from the Albian of Japan, and also the Late Cretaceous seep faunas in Japan have a very modern appearance. Inoceramid bivalves occur sporadically in seeps throughout the Cretaceous, but their ecologic role and feeding strategy are still unknown. Methane seepage was widespread in the Western Interior Seaway of North America, but these sites were dominated by a species endemic to the Western Interior and apparently did not have an impact on the evolution of the deep-sea seep fauna in general. The suggestions that organic-rich black shales of Cretaceous epicontinental seas were the place of origin of the modern methane seep and hydrothermal vent fauna can not be confirmed.

The geologic ranges of mollusks at seeps indicate that deep-sea anoxic/dysoxic events did not affect these faunas, casting doubt on the suggested anoxic nature and/or global extent of these events. Also the end-Cretaceous mass extinction had little effect on the evolution of the seep fauna, which further supports the view that this extinction event did not affect the deep-sea as much as shallow-water environments.