

Environmental changes spanning the end-Devonian extinction: Evidence from biomarkers

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Oceanic anoxia and marine extinction events occurred several times during the late Devonian marked by development of land vascular plant, which should have produced a lot of organic soils. One of the severe ocean anoxic and extinction events during the late Devonian occurred at the end of the Devonian ("Hangenberg Event" marked by "Hangenberg Black Shale"). However, the cause and processes of this event are still remained unknown. We investigated the strata, which were probably deposited on the continental slope, containing the D/C boundary of the Pho Han Formation located in the Cat Ba Island, eastern Vietnam to show the palaeoenvironment spanning the end-Devonian extinction using organic geochemical analyses.

The values of total organic carbon contents (TOC), total sulfur contents, and dibenzothiophene show a drastic increase from the base of the black shale to the D/C boundary in this section, which suggests anoxic condition extending in the sea at that time. Dibenzofuran and coronene, which are organic molecules indicative of the inputs of organic soils made by land vascular plants, have more detecting points in the beds between the base of the black shale and the D/C boundary than the other beds. Values of cadalene, which is derived from terrestrial higher plant, in the top Devonian beds are ten times of those in the other beds, which also showing an increase in inputs of terrestrial organic soils in the area at that time. Hopanes, which are derived from bacteria, and steranes, which come from eukaryote, are detected continually in the top Devonian beds show distinct increases compared with those in the other beds, and the values of $C_{27}/(C_{27}+C_{29})$ sterane are more than 0.45 indicating the ratio of the organic matters from ocean primary production are more than that from terrestrial plants. These results indicate that bacteria and eukaryote kept on being active during the end of the Devonian, and thereby marine-derived organic matters are dominant compared with terrestrial-derived organic matters. It may have been resulted from the increases of the inputs of terrestrial nutrients. The increase in oceanic primary productivity may have caused consumption of seawater oxygen and reducing environment expanding in the sea resulting high TOC. Moreover, the values of 2-methyltetradecane and 3-methyltetradecane, which are derived from sulfate reducer, and aryl isoprenoids, which could come from green sulfur bacteria, show increases more continually in the top Devonian beds, implying that sulfate reducer kept on being active and reducing environment extended up to the photic zone in the sea at that time. Input of soils leading reducing environment in the sea may have caused the end-Devonian extinction.