A multi-isotope approach to understand paleoenvironmental perturbations of the late Ordovician mass extinction event

TERUYUKI MARUOKA[1], SACHIKO AGEMATSU[1], KATSUO SASHIDA[1], AND NIZA MAT[2]

[1]Graduate School of Life and Environmental Sciences, University of Tsukuba
[2] Geological Survey of Malaysia

The late Ordovician [Ordovician-Silurian (O-S)] mass extinction was the first among the “Big Five” mass extinctions of the Phanerozoic era and the first that affected animal-based communities. This event was likely related to the glaciation of Gondwana; however, the exact mechanisms that led to widespread extinctions are still unclear. The elevated extinction rates were accompanied by a positive carbon isotope ($\delta^{13}C$) excursion. Therefore, not only climatic cooling or a major sea level drop can be related to this mass extinction, both of which are directly related to glaciation, but a major perturbation of the global carbon cycle might also have been involved. However, it is very difficult to draw conclusions about the oceanic events from $\delta^{13}C$ data alone. Therefore, a multi-isotope approach should be applied in order to understand the paleoenvironmental perturbations in oceans during the late Ordovician mass extinction event.

In this study, isotopic ratios and concentrations of carbon and sulfur were analyzed in the Upper Ordovician to Lower Silurian shales from the Langkawi Islands in Malaysia. The results revealed that the weight ratios of organic carbon and pyritic sulfur (C/S) varied periodically from <1 to ~30. These periodic variations were interrupted by the position of the positive $\delta^{13}C$ excursion. The excursion was accompanied by C/S ratios <0.1, lower than the minimum values during the periodical variations. These results imply that the depositions of organic carbon and pyritic sulfur occurred in highly anoxic oceans that might have contained hydrogen sulfide in the water column. At the onset of the late Ordovician mass extinction, characterized by the $\delta^{13}C$ excursion, highly anoxic water bodies containing hydrogen sulfide likely expanded to form shallow oceans where sand deposition occurred.