

## Molecular isotopic evidences of euxinic oceans of the past

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Green sulfur bacteria are obligately anaerobic photoautotrophic bacteria that inhabit known to live in reduced water masses such in stratified basins. Anoxygenic photosynthesis of green sulfur bacteria uses sulfide ions as an electron donor, hence obligately requiring presence of hydrogen sulfide in their living environment. Green sulfur bacteria produce unique photopigments such as bacteriochlorophylls *c*, *d*, and *e* as well as isorenieratene. Significantly, these compounds are long preserved in sediments and sedimentary rocks as porphyrins and isorenieratane, respectively. Thus, occurrences of these molecular markers are strong evidence of green sulfur bacteria, indicating presence of euxinic (free of oxygen + presence of hydrogen sulfide) water mass within photic zone of the sea surface. We have detected sedimentary porphyrins derived from bacteriochlorophylls *c*, *d*, or *e* from black shales of the Cretaceous OAEs, the Permian/Triassic boundary, a mid-Miocene rock deposited in a back arc basin (the Onnagawa Formation), as well as Neoproterozoic shales, indicating surface water euxinia in these environments. We further analyzed nitrogen isotopic compositions of these porphyrins and reconstructed nitrogen cycles, which should provide crucial information to understand the forcing mechanisms of the euxinia in the past.