A highly redox-heterogeneous ocean in South China during the early Cambrian (~529-514 Ma): Implications for biota-environment co-evolution

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The "Cambrian Explosion" is known for rapid increases in the morphological disparity and taxonomic diversity of metazoans. It has been widely proposed that this biological event was a consequence of oxygenation of the global ocean, but this hypothesis is still under debate. Here, we present high-resolution Fe-S-C-Al-trace element geochemical records from two outer-shelf Jinsha and Weng'an sections of the early Cambrian Yangtze Platform, integrating these results with previously published data from six correlative sections representing a range of water depths. Our results suggest that euxinic mid-depth waters dynamically coexisted with oxic surface waters and ferruginous deep waters during the earliest Cambrian, but that stepwise expansion of oxic waters commenced during Cambrian Stage 3 (~521-514 Ma). Combined with data from lower Cambrian sections elsewhere, including Oman, Iran and Canada, we infer that the global ocean exhibited a high degree of redox heterogeneity during the early Cambrian. A large spatial gradient in pyrite sulfur isotopic compositions (averagely from -12.0‰ to +22.5‰) imply low seawater sulfate concentrations.

By comparing our reconstructed redox chemistry with fossil records from the lower Cambrian of South China, our results suggest that the "Cambrian Explosion" in South China may have been primarily a consequence of locally improved oxygenation of the ocean-surface layer rather than of the full global ocean. Our studies further suggest that the influence of early Cambrian animals on contemporaneous ocean chemistry, as proposed in previous studies, may be overly exaggerated.