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Three oceanic oxidation events coincided with diversification of early animals after the Snowball Earth

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The terminal Proterozoic to earliest Phanerozoic (650-500 Ma) is a critical period of life evolution on Earth, marked by the emergence of the (i) Lantian biota, (ii) diversification of the Ediaraca biota, and (iii) the Early Cambrian Metazoan Explosion. These three bioevents apparently set an evolutionary agenda for animals to eventually proliferate on Earth during the Phanerozoic. Although a causal link between environmental amelioration and metazoan emergence or proliferation in the mid-Ediacaran (580 Ma) has been discussed, the precise relationship between environmental changes, in particular redox condition changes and these three major bioevents have long remained disputed. We investigated sedimentary organic molecules from 660 to 510 Ma as a proxy for redox conditions in three water depth settings, surface water, shallow intermediate water, and deep intermediate water. Samples were taken from South China, Oman, and Australia. Those data show that three major oxidations in the intermediate water occurred just after the Marinoan Snowball Earth (635 Ma), the Gaskiers Glaciation to the Shuram event (580-555 Ma), and in the earliest Cambrian (515-525 Ma). These oceanic oxidation events coincided with the emergence of the Lantian Biota, the proliferation of the early Ediacaran Biota, and Cambrian explosion, respectively. Moreover, this analysis also shows that anoxia occurred in surface water during the Marinoan Glaciation and Ediacaran-Cambrian boundary, across which the Ediacaran Biota were wiped out. Thus, oceanic redox condition changes played a crucial role driving the origination, evolution and extinction of early animals.

Keywords: Ediacaran, Cambrian, Snowball Earth, oceanic oxidation, oceanic anoxia, early animals