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A two-step rise of oxygen concentration in shallow seas coinciding with the rise of animal life in Ediacaran-Cambrian

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Two of the most significant events in Earth biotic evolution occurred in the Ediacaran and the early Cambrian periods. The first event is characterized by the appearance of primitive marine animals such as sponges and cnidarians in the Ediacaran, and the second step is the appearance of diverse marine animals in the early Cambrian. However, the cause of these macroevolutionary steps has not been clarified. Here we show that a two-step rise of oxygen level in shallow seas coincided with the rise of animal life in the Ediacaran and Cambrian. The changes in dissolved oxygen, marked by an organic molecular index, the pristane/phytane ratio, are detected from shallow marine sedimentary rocks from northwestern Australia and southern China. Low dissolved-oxygen conditions above storm wave base developed frequently in the early Ediacaran before and during the Gaskiers glaciation and end-Ediacaran to earliest Cambrian, before the Cambrian Explosion. High dissolved-oxygen conditions above storm wave base continued in late Ediacaran and into the time of the Cambrian Explosion. The high dissolved-oxygen conditions coincided with the Ediacaran biota and the early Cambrian fauna. Additionally, sporadic data from below storm wave base show low dissolved-oxygen conditions in the late Ediacaran, and high dissolved-oxygen conditions during and after the Cambrian Explosion horizon. We hypothesize that the two-step rise in dissolved oxygen is related to the two-step evolution of metazoans in the mid-Ediacaran and the Cambrian.

Keywords: Ediacaran, Cambrian, oxygen concentration, shallow sea, animal life