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Understanding the relationship between rise of oxygen and gene expression of cyanobacterial antioxidant enzymes

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Though free oxygen (O_2) was absent from the atmosphere during the first half of Earth's 4.5-billion-year history, which is considered to have increased dramatically at the beginning and the end Proterozoic ($\sim$2.2 and $\sim$0.6 billion years ago, respectively). Recent geochemical data suggest that such transitions to an oxic atmosphere were not unidirectional, but appear to have associated with an overshoot and/or a downshoot of the O_2 levels. Such dynamic changes in the redox conditions in the atmosphere must have posed severe environmental stresses to life on Earth. However, how the changes in the O_2 levels affected the biosphere has been poorly understood. Answering this question is of fundamental importance in understanding Earth's history.

Here we focused on the changes in the expression of genes encoding antioxidant enzymes of cyanobacteria through history. Changes in environmental O_2 levels must have affected the production of reactive oxygen species, which in turn affected antioxidant gene expression. Gene expression is regulated by the nucleotide sequence in the promoter regions. Thus we hypothesized that the ancestral promoter sequences of the antioxidant enzymes may reflect the environmental O_2 levels at the time the ancestor existed. In this study, we resurrected the ancestral promoter sequences of the antioxidant enzymes, and discuss its relationship to the O_2 evolution through time. In this presentation, we will first introduce recent models of the atmospheric O_2 evolution through Earth's history, then we will report our progress in resurrecting ancestral promoter sequences of cyanobacterial antioxidant enzymes.

Keywords: rise of oxygen, antioxidant enzymes, cyanobacteria