Oxygen fuels the fires of time

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Variations in the Earth's atmospheric oxygen levels are thought to be closely linked to the evolution of life, with strong feedbacks between uni- and multicellular life and oxygen. Over the past 400 million years the level of oxygen has varied considerably from the 21% value we have today. Scientists from The Field Museum in Chicago and Royal Holloway University of London publishing their results this week in the journal *Nature Geoscience* have shown that the amount of charcoal preserved in ancient peat bogs, now coal, gives a measure of how much oxygen there was in the past.

Until now scientists have relied on geochemical models to estimate atmospheric oxygen concentrations. However, a number of competing models exist, each with significant discrepancies and no clear way to resolve an answer. All models agree that around 300 million years ago in the Late Paleozoic atmospheric oxygen levels were much higher than today. These elevated concentrations have been linked to gigantism in some animal groups, in particular insects, the dragonfly *Meganeura monyi* with a wingspan of over two feet epitomizing this. Some scientists think these higher concentrations of atmospheric oxygen may also have allowed vertebrates to colonize the land.

These higher levels of oxygen were a direct consequence of the colonization of land by plants. When plants photosynthesize they evolve oxygen. However, when the carbon stored in plant tissues decays atmospheric oxygen is used up. To produce a net increase in atmospheric oxygen over time organic matter must be buried. The colonization of land by plants not only led to new plant growth but also a dramatic

increase in the burial of carbon. This burial was particularly high during the Late Paleozoic when huge coal deposits accumulated.

Dr. Ian J. Glasspool from the Department of Geology at the Field Museum explained that: "Atmospheric oxygen concentration is strongly related to flammability. At levels below 15% wildfires could not have spread. However, at levels significantly above 25% even wet plants could have burned, while at levels around 30 to 35%, as have been proposed for the Late Paleozoic, wildfires would have been frequent and catastrophic".

The researchers, including Professor Andrew C. Scott from the Royal Holloway University of London, have shown that charcoal found in coal has remained at concentrations of around 4-8% over the past 50 million years indicating near to present levels of atmospheric oxygen. However, there were periods in Earth History when the charcoal percentage in the coals was as high as 70%. This indicates very high levels of atmospheric oxygen that would have promoted many frequent, large, and extremely hot fires. These intervals include the Carboniferous and Permian Periods from 320-250 million years ago and the Middle Cretaceous Period approximately 100 million years ago.

"It is interesting", Professor Scott points out, "that these were times of major change in the evolution of vegetation on land with the evolution and spread of new plant groups, the conifers in the late Carboniferous and flowering plants in the Cretaceous". These periods of high fire resulting from elevated atmospheric oxygen concentration might have been self-perpetuating with more fire meaning greater plant mortality, and in turn more erosion and therefore greater burial of organic carbon which would have then promoted elevated atmospheric oxygen concentrations. "The mystery to us", Scott states, "is why oxygen levels appear to have more or less stabilized about 50 million years ago".

More information: Glasspool, I.J. and Scott A.C. 2010. Phanerozoic atmospheric oxygen concentrations reconstructed from sedimentary charcoal. Nature Geoscience DOI:10.1038/NGEO923

Provided by Field Museum