

## **Water Table Fluctuation Controls Hydrogen Peroxide Distribution in Unconfined Aquifer**

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Production of reactive oxygen species (ROS) has been documented in subsurface environments, whereas factors controlling the dynamics of ROS distribution in aquifers are poorly understood. Here we show that hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) distribution in an unconfined aquifer is regulated by water table fluctuations. In one hydrological year, we measured the dynamics of H<sub>2</sub>O<sub>2</sub> distribution in an unconfined aquifer impacted by a 17-m water level fluctuation in the adjacent Yangtze river. H<sub>2</sub>O<sub>2</sub> concentrations in groundwater were high, up to 123 nM, when the water table was rising in Summer, were moderate when the water table was stabilized at high level in Autumn, and were minimal when water table was falling at Winter and stabilized at a low level in Spring. H<sub>2</sub>O<sub>2</sub> in the groundwater was mainly produced by the abiotic interaction of O<sub>2</sub> with reduced species. Both mechanism and modeling suggest that water table fluctuations regulated the dynamics of H<sub>2</sub>O<sub>2</sub> distribution in the aquifer through controlling the supply of dissolved O<sub>2</sub> and the biogeochemical reactions related to reduced species. Our findings supplement the fundamentals for understanding reactive oxygen species distribution in subsurface environments.