10 grams of sediment or soil were added to 50 mL proteomic friendly tubes and equilibrated overnight at 21°C. The next morning, samples were inundated with groundwater (soils) or river water (sediments) and sealed with a modified tube cap and optode disks that are coated with an oxygen sensitive dye ensuring no headspace. Samples were placed on roller system where every two minutes, the rollers stopped, blue LED lights turned on and an image was captured before the lights turned off and rolling resumed. This continued for two hours. Dissolved oxygen measurements for each time point were determined from red:green pixel ratios the photographs processed using ImageJ and a calibration curve fit to each optode disk. Respiration rates were calculated as the slope of the linear regression between dissolved oxygen measurements and incubation time. The theoretical dissolved oxygen at time zero was removed if the time two minute was greater than the 5.5 mg/L threshold. The two minute time point was removed if the first picture was taken at the same time the sample was put on the multireactor rolling system. Samples were normalized to milligrams of oxygen per kilogram of sediment using the estimated dry mass of sediment and water mass in the incubation vial.

Optode disks were coated with a dyes sensitive to oxygen concentration following Larsen et al. [(2011)](https://www.zotero.org/google-docs/?W48mQE) and Kaufman et al. [(2023)](https://www.zotero.org/google-docs/?CZ67eD). Oxygen concentration is described by a modified Stern-Volmer equation, which relates oxygen concentration to a ratiometric function of red and green luminescence. Optode disks were calibrated weekly in a sealed calibration cell filled with MilliQ water using two digital mass flow controllers (MassTrak 810, Sierra Instruments, Monterey, CA, USA), to control DO concentrations over 20% intervals from 0 - 100% using a gas mixture of Nitrogen and air. Calibration curves and inputs for the Stern-Volmer equation (ratiometric absent oxygen, nonquenchable signal fraction, Stern-Volmer quenching constant) were generated for each disk by taking a photograph at each DO concentration using a modified DSLR camera controlled by Look@RGB software.

Dissolved oxygen concentrations for each sample at each time point was performed following image analysis workflows from Kaufman et al. [(2023)](https://www.zotero.org/google-docs/?MiIPDK). In short, we used ImageJ software (National Institute of Health, Bethesda, MD, USA) to trace the outline of each individual disk in a photograph and to calculate the average intensity of the red and green light filter from each disk. The ratio of (red - green)/green pixels was used was then converted to convert to dissolved oxygen for each time point using the ratiometric absent oxygen, nonquenchable signal fraction, and Stern-Volmer quenching constant generated from the calibration curve fitted to each optode disk using Spyder (Spyder IDE v5)