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Investigation of cave air ventilation and CO2 outgassing by radon-222

Knowledge of cave ventilation processes is required to quantify the effect variations in CO2 concentrations which have on speleothem deposition rates and thus paleoclimate records. In this study we use radon-222 (222Rn) as a proxy of ventilation to estimate CO2 outgassing from the cave to the atmosphere, which can be used to infer relative speleothem deposition rates. We have measured radon concentration from Cango Cave, a tourist cave preserve in Oudthroun, Western Cape Province, South Africa using Electret ion chamber and Rad 7 in order to excess radon migrated from cave soil and drip water. Average cave air 222Rn concentrations vary seasonally between winter (222Rn=50 dpm L−1, where 1 dpm L−1=60 Bq m−3; CO2 =360 ppmv) and summer (222Rn=1400 dpm L−1; CO2 =3900 ppmv). Large amplitude diurnal variations are observed during late summer (222Rn=6 to 581 dpm L−1; CO2=360 to 2500 ppmv). We employ a simple first-order 222Rn mass balance model to estimate cave air exchange rates with the outside atmosphere. Ventilation occurs via density driven flow and by winds across the entrances which create a 'venturi' effect. The most rapid ventilation occurs 25 m inside the cave near the entrance: 45 h−1 (1.33 min turnover time). Farther inside (175 m) exchange is slower and maximum ventilation rates are 3 h−1 (22 min turnover time). We estimate net CO2 flux from the epikarst to the cave atmosphere using a CO2 mass balance model tuned with the 222Rn model. Net CO2 flux from the epikarst is highest in summer (72 mmolm−2 day−1) and winter (12 mmolm−2 day−1). Modelled ventilation and net CO2 fluxes are used to estimate net CO2 outgassing from the cave to the atmosphere. Average net CO2 outgassing is positive (net loss from the cave) and is highest in late summer and early autumn (about 4 mol h−1) and lowest in winter (about 0.5 mol h−1). Modelling of ventilation, net CO2 flux from the epikarst, and CO2 outgassing to the atmosphere from cave monitoring time-series can help better constrain paleoclimatic interpretations of speleothem geochemical records.

Apply to be
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