



## **Carbon isotopes in drip water and stalagmites - tracers of soil processes**

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The carbon isotope composition of soil air and soil water is influenced by climate. Here we apply the carbon isotope composition of speleothems in the Ernesto cave in Trentino, Italy, for the reconstruction of the conditions of the soil above the cave during the Holocene.

In a first step a numerical model that describes the isotope composition of drip water upon reaction with the calcite of the karst was developed. The model allows for open and closed limestone dissolution systems as well as intermediate dissolution conditions computed by successive contributions of the open and closed system. A second model accounts for the isotope fractionation processes occurring during degassing of  $\text{CO}_2$  and precipitation of  $\text{CaCO}_3$  in caves. This model simulates a Rayleigh distillation process under equilibrium fractionation and additional gas exchange with cave air.

The reconstruction of recent and past soil  $\text{pCO}_2$  is then performed by inverse modelling of the  $^{14}\text{C}$  and  $\delta^{13}\text{C}$  composition of monthly collected cave drip water and of a well dated stalagmite. The model is assessed by the comparison of the calculated and of the monthly measured soil  $\text{pCO}_2$ . The reconstruction delivers a probable range and seasonality of recent soil  $\text{pCO}_2$ , although the solution is not unique, due to the uncertainties originating in the unknown degree of open and closed system conditions during the limestone dissolution. The convincing model performance for the present day situation allows to apply the model to a Holocene stalagmite. This reconstruction of past soil conditions reveals an increasing soil  $\text{pCO}_2$  within the last 5000 years in the soil above the cave.