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Vadose zone hydrology of an Alpine karst system inferred from dripwater stable isotopes.

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Bossea cave is located in the Ligurian Alps of southern Piedmont (Italy). It represents the termination of a karst system that is comprised between 800 and 1700 m a.s.l. and it has a catchment area of about 6 km2. The cave hosts an underground river fed by several small tributaries that drain the vadose zone. The water resurfaces in the Corsaglia river. An underground scientific laboratory studies the karst system since 1969. The secondary tributaries have been progressively equipped with loggers and multiparametric devices in order to monitor their hydrodynamic behaviour. The most important of these inflows are called "polle": they have relatively high and constant discharges and drain wide open fractures. The secondary tributaries with low discharges are dripsites that drains networks of small fractures.

Seasonal sampling of rainfall (collected above the cave) and water from the secondary inflows and the underground river were carried out during 2018 for water stable isotope analysis (δ18O and δ2H). Among the dripsites, the one with the highest discharge (called "Milano") was equipped with an automatic sampler to monitor the water isotopic composition during three precipitation events occurred between mid-October and the beginning of November (corresponding with the onset of the recharge phase of the karst aquifer). The automatic sampler collected a sample every 6 hours. The same dripsite was also equipped with a multiparametric device that measured water level, water temperature and electrical conductivity. The stable isotopes were analysed at the Institute of Geology of Innsbruck by means of a CRDS Picarro L2140-i.

The isotopic composition of rainfall varied between -13,02‰ and -5,65‰ for δ18O (average -10,19‰ VSMOW) and between -91,43‰ and -27,63‰ for δ2H (mean -67,01‰ VSMOW), reaching the lightest compositions in January and March while the heaviest composition was recorded during a rainfall in October, probably related to the source of the air mass. The secondary tributaries are characterized, on average, by lighter isotopic compositions in January and March (δ18O comprised between -13,26‰ and -11,24‰ whereas δ2H ranged between -92‰ and -77,41‰) than during October and November (δ18O comprised between -11,96‰ and -8,61‰ whereas δ2H ranged between -81,13‰ and -55,45‰). With few exceptions, their isotopic values are heavier or equal to that of the rainfall sampled on the same date. The underground river had a quite stable composition during the whole year, but it had the peculiarity of being heavier than the corresponding rainfall during March and lighter than the rainfall during October and November. The isotopic composition of Milano dripsite, obtained during the monitoring of the three autumnal rainfall events, is comprised between -11,6‰ and -8,7‰ for δ18O and -79,3‰ and -59,7‰ for δ2H.

The monitoring of both the isotopic composition and the hydrological parameters revealed that water discharged by the vadose zone during the onset of the recharge phase is a mixture between the isotopically light water stored in the small fractures (accumulated after the infiltration of snowmelt in spring), and the relatively heavy rainfall infiltrated during the precipitation events.