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Identifying karst water sulfate and nitrate sources by combined use of isotopic and ionic ratios

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Combined use of δ34S and Ca2+/Na+ molar ratio and δ15N and NO_3-/Na+ ratio may identify karst water SO42− and NO_3- sources. With characteristic isotopic and ionic ratios from China, especially Guizhou province, the relevant end-members are determined as follows. Rainwater may have δ34S, δ15N, Ca2+/Na+, and NO_3-/Na+ values/ratios of $^{-1}$4.0 to −0.8‰ (average −5.4‰, −0.81‰ 22.5, and 10.7, respectively (Hong et al., 1993; Wu et al., 2018). They could be $^{-1}$2.01 to −2.51‰ (average −7.52‰ for δ34S and 0.0–1.5 (average 0.4 ± 0.5) for Ca2+/Na+ in terms of waters leaching coal (Hong et al., 1993; Li et al., 2018). Waters draining carbonates and gypsum are probably characterized by δ34S values of 14.5–32.5‰ with Ca2+/Na+ ratios of 50–200 and 13.2, respectively (Chen and Chu, 1988; Gaillardet et al., 1999; Huang et al., 2016). For waters affected by chemical fertilizers, δ34S values of −5.6 to 7.7‰ (average −0.8‰ and a Ca2+/Na+ ratio of 279 are likely related to superphosphate; δ15N values of −5.61 to 3.98‰ (average −0.35 ± 1.90‰ and 1.91 to 21.33‰ (average 8.69 ± 5.78‰ represent NH4+ in chemical fertilizer and NO_3- in $NH4NO_3$ fertilizer, respectively, with NO_3-/Na+ ratios of ∼10 (Cao et al., 1991; Li et al., 2006; Roy et al., 1999; Rui et al., 2008). Waters leaching red soil may show δ15N values and NO_3-/Na+ ratios of 1.00 to 1.56‰ (average 1.29 ± 0.20‰ and 2.4–5.3, respectively (Cao et al., 1993; Wu et al., 2018). The δ15N values of 7.47 to 49.71‰ caused by human waste, with NO_3-/Na+ ratios of 0.01 to 0.38 may be assigned to domestic sewage (Wu et al., 2018; Xing et al., 2001).

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