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The geochemical characteristics of soil water and epikarst springs and their response to vegetation-soil degradation in a karst area

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Samples of soil waters and epi-karst springs in four vegetation types were collected at Maolan nature reserve in Libo county, which including protogenetic arbors, secondary arbor-shrub, shrubs and shrub-grass, to analyze their hydro-geochemical properties and the variations of nutrient elements, and further to illustrate the intrinsic correlations of vegetation, soil, environment changes and their geochemical information. The conclusions have been concluded as follows:

(1) The pH of soil waters in the study area varies between 5.32 and 7.93, with a mean value of 6.78, and the conductivity changes between 31.82 and 353.65 μS/cm, with a mean value of 126.19 μS/cm. Both descend as the vegetation degrades. The hydro-chemistry of soil waters are Ca- HCO_3^-, and their ions mainly consist of Ca^{2+}, Mg^{2+}, HCO_3^-, SO_4^{2-}. Ca^{2+}, Mg^{2+}, HCO_3^- are very sensitive to vegetations degradation. Ion contents are high in rain seasons and low in dry ones.

(2) The pH of surface karst springs in the study area vary between 6.7 and 8.42, with a mean value of 7.65, and the conductivity between 125.6 and 452 μS/cm, with a mean value of 288.09 μS/cm. The hydro-chemistry of surface karst springs are Ca- HCO_3^-. HCO_3^- and SO_4^{2-} are the main anions while Ca^{2+} and Mg^{2+} as main cations. The chemical properties and geochemical process of surface springs are mainly controlled by the solubility equilibrium of carbonate rocks, thus not sensitive to vegetation degradations.

(3) All the calcite saturation indices of soil waters in four vegetation types are below 0, while most indices of surface karst springs are above 0, demonstrating greater denudation of soil waters than surface karst springs. As soil waters flow to surface springs, the partial pressure of CO_2 decreases, the denudation of water lessens, and saturation index, Ca^{2+}, HCO_3^-, consequently, pH and conductivity increase.

(4) Inorganic nitrogen in soil waters exist mainly as N-NO_3^- and N-NH_4^+, accounting $\sim$ 95% of the 3 Ns. As vegetation degrades, nitrate nitrogen, organic nitrogen and total nitrogen change in follow way, protogenetic arbors $>$ secondary arbor-shrub, shrubs $>$ shrub-grass, but the differences among all vegetation types are not prominent. Ammonia nitrogen, however, changes otherwise as follows: shrubs, shrub-grass $>$ protogenetic arbors, secondary arbor-shrub.

In surface springs, few inorganic nitrogen exists as NO_2^--N (2 μg/L on average), and most exists as NO_3^-N (215 μg/L on average), and NH_4^+-N is 185μg/L on average. In general, NH_4^+-N, NO_3^--N and TN formations in the four vegetation types are: protogenetic arbors $>$ secondary arbor-shrub $>$ shrubs $>$ shrub-grass.

(5) DOC content in soil waters vary between 1.88 and 10.37 mg/L, with an average 4.8 mg/L. DOC content in surface karst springs changes between 0.39 and 9.98 mg/L, with an average 2.25 mg/L. DOCs in soil waters are greater than those in surface karst springs in all four vegetation types, and have sharp differences ($P \leq 0.01$). DOCs in soil waters and surface karst springs share a great relationship and a similar change tendency, which well illustrates a main source of surface springs from soil waters. In both of them, DOCs are larger in original vegetations than in degraded vegetations. This is because the soil-vegetation system is stable in an original ecology environment which free from outside disturbs. By contrast, a degraded system is unstable, weak at beating disturbs, and conserves less but loses more.

Key words: soil waters, epi-karst springs, hydro-geochemical, vegetation, karst area, Maolan in Guizhou