Sulfur cycling in deep groundwater hosted by metamorphic rocks in a rapidly exhumed catchment

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Chemical weathering plays an essential role in regulating the global carbon cycle and ocean chemistry over contemporary and geological time scales. While chemical weathering is controlled by a number of factors, quantifying individual contributions remains challenging and incomplete. Among them, groundwater circulation within metamorphic orogens has been speculated to export substantial quantities of solutes. The lack of representative wells often impedes to resolve the end component characteristics generated from mineral dissolution and the effect of hydraulic properties on weathering mechanism and rate.

This study aims to investigate the temporal variations in geochemical characteristics of groundwater retrieved from boreholes in the rapidly uplifting Sinwulyu catchment of southeastern Taiwan. The bedrock of the investigated region is composed of primarily greenschist, mica schist, and metabasite. Analyses of groundwater collected at two sites yielded Na^{+}, Ca^{2+}, Mg^{2+}, SO_4^{2-} and dissolved inorganic carbon as the major constitutes. Their concentration variations were generally distinct from those of river water. The patterns combined with water isotopic compositions and groundwater levels suggest the potential compartmentalization of groundwater into at least two separate reservoirs experiencing different degrees of water-rock interaction and exchange with river water. Furthermore, SO_4^{2-} in deep groundwater was enriched in both ^{34}S and ^{18}O. Depending on the site, its concentration was either more or less abundant than shallow groundwater and river water. Such abundance-isotope combination patterns are primarily accounted for by pyrite oxidation and microbial sulfate reduction. The role of gypsum dissolution remains ambiguous. Overall, these results demonstrate a complex control of groundwater circulation on subsurface sulfur cycling inherited with metamorphic rocks in a rapidly uplifting catchment.