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Water-rock interactions in periglacial conditions from the Zayu area, SE Tibet

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Weathering associated with bedrock landslides has great influence on the solute chemistry in active mountain rivers, such as in the Western South Alps and Taiwan Orogeny [1-4]. Bedrock landslides generate deposits with fresh surfaces and high porosity, favorable for enhanced chemical weathering. Driven by the weathering of reactive phases (biotite and carbonate)[3] and potential sulfuric acid weathering [2,4], the seepages from those deposits are characterized by high total dissolved solid (TDS) [1] and high relative concentration of K^+, Ca^{2+} and SO_4^{2-}[2,4]. However, the existing studies are all from tropical to temperate climate conditions, and we are lacking case studies from high-altitude alpine regions and periglacial conditions such as cold and poorly vegetated settings.

The Zayu catchment on the SE margin of Tibetan Plateau spans great geographical gradient. The north of the catchment is in a periglacial alpine desert-meadow environment. The valley is widely covered by deposits related with talus fans or rock glacier, likely to be continuously fed by the freeze-thaw processes on mountain slopes. The south of the catchment is in temperate-subtropical monsoonal forest environment and is influenced by bedrock landslides.

We conduct comparative study for the seepages from the fan deposits in the north and the landslide in the south, as well as local stream waters in both part of the catchment, in terms of their solute load. In the south, the landslide seepages have a systematically higher Ca^{2+}/TDS, K^+/TDS and SO_4^{2-}/TDS ratiosthan local streams, likely related with the recent exposure of sulfide, biotite, and carbonate. This result reproduces the pattern found in WSA and Taiwan and extends it to granitoid lithology characteristic of the Zayu catchment, suggesting a universal weathering mechanism for landslide deposits. In the north, the seepages and the nearby streams have nearly identical chemical characteristics, with variable, TDS, K^+, Ca^{2+} and SO_4^{2-} concentrations, but similar than in the south, on average. It suggests that the mass wasting deposits in periglacial conditions can promote chemical weathering, playing a similar role than the bedrock landslides in temperate conditions, and the universal freeze-thaw process in the north periglacial catchment could be responsible for enhancing chemical weathering, as it creates fresh surface, enlarge cracks that promote hydraulic conductivity, and reduce the time for adequate water-rock interaction.

Reference: