Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9750

The constancy of chemical weathering intensity on hillslopes in the arid to semiarid Qilian Mountains, NE Tibetan Plateau

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Quantifying the relationship between the chemical weathering rate and denudation rate of active orogenic belts in broad environments is the key to addressing the controversy over the uplift-weathering hypothesis. However, studies have focused on warm and humid environments and have not examined in cold and arid environments. Here, we present a new dataset of the chemical depletion fraction (CDF: ratio of the chemical weathering rate to the total denudation rate) across the arid to semiarid Qilian Mountains on the northeastern Tibetan Plateau, where the uplift-weathering hypothesis has been proposed and is widely known. We found no clear correlation between the CDF and any climatic (temperature, precipitation and normalized difference vegetation index (NDVI)) or topographic factors (slope and local relief). We then compared the published catchment-averaged denudation rates with the average CDF in each catchment. Despite 30-fold differences in denudation rates, the CDFs are nearly constant, demonstrating that the chemical weathering rate can keep pace with the denudation rate in this arid and cold landscape. This result indicates that the Qilian Mountains are under supply-limited conditions, even at high denudation rates (more than 800 $t \cdot km^{-2}y^{-1}$). We speculate that low temperatures could intensify near-surface weathering by freezing-thawing processes. This mechanism causes a compensation effect, isolating the kinetic-limited conditions from the landscape with high denudation rates. Our findings highlight the importance of chemical weathering in arid and cold orogenic belts during late Cenozoic global cooling.