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Silicate Weathering Rates in Tropical Mountain Headwater Catchments, Southeastern Brazil

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Hydrogeochemical studies of small tropical granitic watersheds remain scarce since the pioneering work of Garrels and Mackenzie (1967). Here, we investigate weathering processes in three small headwater catchments (8–17 km²): Soberbo (SB), Bonfim (BM), and Santa Marta (SM) developed on similar granite–gneiss substrates with steep slopes (~50%) under rainforest conditions in southeastern Brazil. SB and BM are located in Serra dos Órgãos National Park (Rio de Janeiro State; mean annual temperature 18 °C) on the oceanic and continental slopes, respectively. Annual precipitation and runoff are 2,872 and 2,097 mm yr^{-1} in SB, and 2,018 and 1,473 mm yr^{-1} in BM. SM is situated on the oceanic slope of Caparaó National Park (Espírito Santo State; mean annual temperature 16 °C), with precipitation and runoff of 2,189 and 1,291 mm yr^{-1}. River water and atmospheric bulk deposition were sampled monthly for 22 months (May 2018–February 2020). Electrical conductivity, pH, and discharge were measured in situ. Concentrations of Na^+, K^+, Ca^{2+}, and Mg^{2+} were determined by ion chromatography; dissolved SiO_2 by ICP-OES; and alkalinity by titration. Silicate weathering rates (SWR) differ markedly among catchments: 6,199 mol ha^{-1} yr^{-1} in SB, 3,270 mol ha^{-1} yr^{-1} in BM, and 1,220 mol ha^{-1} yr^{-1} in SM. Dissolved silicon accounts for more than half of total SWR (65% in SB to 74% in SM). Considering the cation-derived silicate weathering rate (SWRcat), Na^+ shows the highest contribution (186 mol ha^{-1} yr^{-1} in SM to 1,275 mol ha^{-1} yr^{-1} in SB), emphasizing the role of Na-plagioclase weathering. Mineralogical differences further modulate elemental fluxes: Ca-plagioclase explains Ca fluxes in SB; K-feldspar controls K^+ fluxes in BM; and pyroxenes and amphiboles account for Ca^{2+} and Mg^{2+} fluxes in SM. The comparatively low SWR in SM may reflect reduced microporosity due to the absence of biotite, precipitation of amorphous secondary phases (up to 40% in topsoil), and/or lower runoff. These results highlight the influence of mineralogy on silicate weathering dynamics in tropical mountainous catchments.

Garrels, R.M., and Mackenzie, F.T. (1967). Origin of the chemical compositions of some springs and lakes. *Advances in Chemistry Series*, 67, 222–242.