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Base cation availability in soils along a glacial retreat chronosequence in China: stocks, release, and stable isotope tracing

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Many glaciers in high mountain areas are retreating worldwide because of the increasing temperatures. Following glacial retreat, a fast vegetation succession helps preventing mountain risks such as landslides, erosion, or flooding. Although pioneer plants usually start colonizing young surfaces a few years after glacier melt, it usually takes several centuries to develop a full vegetation cover. Surprisingly, in the subtropical Hailuogou glacial retreat area (approximately 3000 m a.s.l., 1950 mm precipitation, mean annual temperature 4.2 °C), Sichuan, southwest China, a development from bare soil to full coniferous forest occurred in only 80 yr. To improve the understanding of this fast vegetation development along the Hailuogou chronosequence, we (i) evaluated a possible link between Ca, Mg and K supply and vegetation establishment, (ii) determined their release kinetics from topsoils with a weathering experiment, and (iii) measured stable Mg isotope ratios in different compartments.

Total ecosystem Ca and Mg stocks decreased along the chronosequence, while that of K was unrelated with ecosystem age. The decrease of Ca and Mg mostly occurred during the first 47 years, when they were leached at rates of 130±10.6 g m^{-2} $year^{-1}$ Ca and 35±3.1 g m^{-2} $year^{-1}$ Mg. Carbonate weathering determined the rapid initial Ca but not Mg release. The particularly fast Mg loss in the first years was attributable to leaching of exchangeable Mg and dissolution of chlorite, as revealed by the lower δ^{26}Mg values of the fast (-1.28 ± 0.10 ‰) than the slow reacting (-0.74 ± 0.13 ‰) pool at the youngest site in our weathering experiment. We found a close correlation between the δ^{26}Mg values of the mineral topsoil (0-10 cm) and the Mg depletion rates ($r=0.98$, $p<0.001$, $n=6$), which suggests that δ^{26}Mg values can be used as proxy of Mg loss and to identify the sources of this loss in young ecosystems. The well synchronized interplay between carbonate and silicate weathering facilitated the fast vegetation succession along the Hailuogou glacial retreat chronosequence.