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N2-fixing legumes are linked to enhanced mineral dissolution and microbiome modulations in Neotropical rainforests

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Legumes represent the dominant family of many tropical forests with estimates of 120 billion legume trees in the Amazon basin alone. Many rainforest legume trees form symbioses with N2-fixing bacteria. In the process of atmospheric N2-fixation large amounts of nitrogen-rich litter are generated, supplying half of all nitrogen required to support secondary rainforest succession. However, it is unclear how N2-fixers affect the biogeochemical cycling of other essential nutrients by affecting the rates of mineral dissolution and rock weathering. Here we show that N2-fixing legumes in young Panamanian rainforests promote acidification and enhance silicate rock weathering by a factor of 2 compared to non-fixing trees. We report that N2-fixers also associate with enhanced dissolution of Al- and Fe-bearing secondary minerals native to tropical oxisols. In legume-rich neighbourhoods, non-fixers benefited from raised weathering rates relative to those of legume-free zones thus suggesting a positive community effect driven by N2-fixers. These changes in weathering potential were tracked by parallel functional and structural changes in the soil and rock microbiomes. Our findings support the view that N2-fixing legumes are central components of biogeochemical cycling, associated with enhanced release of Fe- and Al-bound P and primary mineral products (Mg, Mo). Rainforest legume services therefore bear important implications to short-term C cycling related to forest growth and the long-term C cycle related to marine carbonate deposition fuelled by silicate weathering.