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The oxalate-carbonate pathway: at the interface between biology and geology

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The formation of calcite in otherwise carbonate-free acidic soils through the biological degradation of oxalate is a mechanism termed oxalate-carbonate pathway. This pathway lies at the interface between biological and geological systems and constitutes an important, although underestimated, soil mineral carbon sink. In this case, atmospheric CO_2 is fixed by the photosynthetic activity of oxalogenic plants, which is partly destined to the production of oxalate used for the chelation of metals, and particularly, calcium. Fungi are also able to produce oxalate to cope with elevated concentrations of metals. In spite of its abundance as a substrate, oxalate is a very stable organic anion that can be metabolized only by a group of bacteria that use it as carbon and energy sources. These bacteria close the biological cycle by degrading calcium oxalate, releasing Ca2+ and inducing a change in local soil pH. If parameters are favourable, the geological part of the pathway begins, because this change in pH will indirectly lead to the precipitation of secondary calcium carbonate (calcite) in unexpected geological conditions. Due to the initial acidic soil conditions, and the absence of geological carbonate in the basement, it is unexpected to find C in the form of calcite. The activity of the oxalate-carbonate pathway has now been demonstrated in several places around the world, suggesting that its importance can be even greater than expected. In addition, new roles for each of the biological players of the pathway have been revealed recently forcing us to reconsider a global biogeochemical model for oxalate cycling.