Biogeochemical cycling of iron oxide in the rhizosphere of plants grown on ferruginous duricrust (canga)

A. PAZ*, E. J. GAGEN, A. LEVETT AND G. SOUTHAM

The University of Queensland, St. Lucia, Queensland 4072, Australia (*correspondence: a.paz@uq.edu.au)

Goethite-cemented duricrusts, also known as canga, protect the underlying iron ore deposits in the elevated plateaus of Carajás province, Brazil. The processes that govern canga formation are still unclear but include recurrent partial dissolution and recrystallisation of goethite through iron reduction and oxidation. Recent studies [1,2] suggest past and present biogeochemical cycling of iron within canga are catalysed by plants and bacteria. Understanding the contribution of endemic metallophyte plants and the associated rhizosphere microorganisms to the iron biochemical cycle is crucial when formulating post-mining rehabilitation strategies for iron ore sites.

Despite the harsh edaphic conditions on this ecosystem, some plants, like *Bulbostylis cangae* of the family Cyperaceae, grow directly in canga (rock). Field observations of these plants provide insight into the role of rock-plant interactions on mineral weathering. Electron microscopy imaging of the canga rhizosphere reveals features representing two opposing processes: (1) mineral dissolution leading to significant residual aluminium enrichment in the iron oxide matrix; and (2) mineral precipitation catalysed by microorganism fossilisation. Synchrotron-based X-ray absorption near edge structure (XANES) affirms the presence of ferrous iron in the weathered material, complexed to organic matter and sorbed to remnant roots, suggesting that the production of organic acids by plants is driving the continuous cycling of iron oxide minerals within iron-rich duricrusts.

To complement the field study, a laboratory experiment was conducted in which model plants where grown on crushed canga in RHIZOtest devices in order to examine the effect of plant exudates on mobilisation of iron. Chemical and mineralogical analyses confirm our hypothesis that, plants that grow in this iron-rich substrate contribute to iron dissolution indirectly (e.g., during phosphate solubilisation), and that the resulting excess iron is redeposited, promoting the cementation of the residual minerals.

[1] Levett et al. (2016) *Journal of South American Earth Sciences* **71**, 131-142.

[2] Monteiro et al. (2018), *Geochimica et Cosmochimica Acta* **229**, 162-183.